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Final Report of Agreement No. INT-96078-RJVA

Submitted to
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**By
Mei-Huey Liu
Ronald H. Wakimoto
School of Forestry
University of Montana
Missoula, Montana 59812**

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1. Introduction

Tropical Africa, which occupies 45% of tropical lands, consists of about 18% of closed forests and 72% of mixed forests-grassland tree formations in tropical countries (FAO, 1981). The impact of human activities on natural vegetation in Africa has been an important issue for the past twenty years. Increasing evidence has shown that biomass burning is causing significant increases in the emissions of trace gases and particulate matter. Hao et al. (1990) and Hao & Liu (1994) have estimated the amount of biomass burned spatially. However, there is little knowledge in the seasonal and interannual variability of biomass burning globally. Daily satellite observations provide the only technical means for deriving the systematic global database on dates and fire locations to estimate the spatial and temporal distribution of fires. We proposed to develop a methodology of using the digital data from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) to study the spatial and temporal distribution of biomass burning in southern Africa, where the Fire Chemistry Unit of the Fire Sciences Laboratory, USDA Forest Service has been conducting field research since 1991. The first phase of this project was proposed to explore the methodology of detecting active fires in southern Africa.

After we have initiated this project, the NOAA National Geophysical Data Center (NGDC) suspended the efforts to develop the database of fire locations in continental Africa because of lack of funding. Therefore, there are no systematic data available to study the seasonal and interannual variability of fires in southern Africa as originally proposed for this research. However, nightly fire maps from 1992 to 1996 for the island of Madagascar were produced with support from the U.S. Geological Survey under the research project funded by USAID. Since the government of Madagascar issued a "no burn" policy after August 31, 1994 in an attempt to reduce widespread biomass burning, the project was to evaluate the effectiveness of government programs to reduce seasonal biomass burning activities in Madagascar.

Although data processed in NOAA NGDC did not cover Zambia as we requested in our proposal, the first multiple-year daily fire detection data set in Madagascar would serve as the baseline for methodology development to provide the spatial and temporal distribution of biomass burning. In addition, the fire data in Madagascar could also be used for a feasibility study to test whether less expensive commercial software, such as IDRISI and ARC/INFO, can be used to process and analyze DMSP data file, since most of the DMSP images are being processed using the proprietary software developed by NGDC.

2. Methodology

The daily time series of fire images from August 1 to December 31, 1992 to 1996, were provided by the NOAA Defense Meteorological Satellite Program (DMSP). The algorithms used for detecting fires were also developed by NOAA. The daily precipitation data was obtained from the National Center for Atmospheric Research (NCAR).

2.1 DMSP Satellite and Data Source

The Defense Meteorological Satellite Program (DMSP) designs, builds, launches, and maintains several near polar orbiting, sun synchronous satellites monitoring the meteorological, oceanographic, and solar-terrestrial physics environments. Each satellite crosses any point on the earth twice a day and has an orbital period of about 101 minutes providing complete global coverage of clouds every six hours. The current orbiting DMSP satellites include F12 with day-night overpasses at ~9:54 and ~21:54 local time, and F-13 with dawn-dusk overpasses at ~6:04 and 18:04 local time. The DMSP Operational Linescan System (OLS) is an oscillating scan radiometer with a swath of 3600 km designed for cloud imaging with two spectral bands, visible and near infrared (VNIR) and thermal infrared (TIR). It has the capability to detect fires at night in a light intensified visible channel. The algorithms developed to detect fires using OLS data were based on detecting active visible and near-infrared emission on the planet surface at night, when solar illumination is absent. The image background is dark, except in locations where cities or fires are located. Georeferenced OLS fire products can be produced after stable light sources from cities, villages, and industrial sites are removed (Elvidge et al., 1996).

The NOAA National Geophysical Data Center (NGDC) archives data for the DMSP sensors. The U.S. Air Force Global Weather Center has been sending DMSP data tapes to NGDC daily. The DMSP digital archive was established in March, 1992 and has received data on a daily basis since September 1992. The archive data set consists of low resolution global coverage and high resolution regional coverage. The OLS produces 85% of the incoming DMSP data. There are two spatial resolution modes, 0.56 km x 0.56 km resolution "fine" data and 2.7 km x 2.7 km resolution smooth data. Most of data received by NOAA National Geophysical Data Center (NGDC) is in smooth resolution. NGDC has recently improved its geolocation accuracy for the OLS data to +/- one pixel using physically based orbital mechanics and terrain correction algorithms. A set of algorithms has been developed for retrieving cloud cover, cloud type, and cloud height from OLS data. The algorithms developed for detection of fires in OLS data rely on detecting areas of active visible and near infrared (VNIR) emission on the planet surface at night, when solar illumination is absent (Elvidge et al., 1996).

DMSP-OLS fire data set for Madagascar was sent by ftp to the University of Montana in July 1997. The resolution of the data was $0.0085^\circ \times 0.0085^\circ$, approximately 1 km x 1 km. It was the most complete data set that DMSP had processed and compiled. It covered daily fire pixels for the months of August to December from 1992 to 1996. Although the data processed in NOAA NGDC did not cover Zambia as we requested in our proposal, we believe that the first complete time-series daily fire data by DMSP-OLS can serve as the baseline for methodology development in studying the spatial and temporal distribution of biomass burning.

Because of funding limitations, the daily fire images were processed from August 1 to December 31, 1992 to 1996, which was considered to be the prime burning season. The data for August, 1992 was discarded because of poor quality of data collected due to flaws of the algorithms.

2.2 Madagascar Vegetation Map

There are a large number of different tropical vegetation classifications, using various ecological, physiognomic and physiographic criteria at both national and regional levels. We use the classification and vegetation map from the Atlas of Archived Vegetation, Land-Use and Seasonal Albedo Data Sets which were compiled by Elaine Matthews (Matthews, 1985) at NASA Goddard Space Flight Center. The vegetation map representing natural (pre-agricultural) vegetation was based on the UNESCO (1973) classification system. This map is limited to a $1^\circ \times 1^\circ$ resolution.

There are primarily two types of vegetation in Madagascar. Two-thirds of Madagascar are grassland. The remainder is tropical or subtropical evergreen seasonal forests along the coasts of Madagascar, especially on the east coast. Eastern Madagascar has high population density. Subsistent rice is grown on fertile volcanic soils in eastern Madagascar. It is also the region for the fastest growth of agricultural population. Human activities have seriously impacted the environment in Madagascar. Deforestation of tropical forests and clearing of mixed forests-grassland tree formations are the two most serious problems in Madagascar. Fires play an important role in land uses including agriculture, grazing or plantation.

2.3 Precipitation data

Since Madagascar is located in the intertropical zone of Africa, rainfall distribution, rather than temperature, is responsible for the seasonality. Rainfall distribution divides the year into two seasons. Precipitation starts to decrease in May. The dry season typically lasts about six months, starting from May to September or October, depending on the regions. In central part of Madagascar, where grassland is the dominant vegetation, the dry season lasts about seven months.

Daily precipitation data from all weather stations in Africa from 1987 to 1998, including twenty-six weather stations in Madagascar, were provided by the National Center for Atmospheric Research (NCAR), Scientific Computing Division, Data Support Section. These twenty-six weather stations scattered from the north to the south, and from the west coast to the east coast of Madagascar, cover different vegetation types. Six sample sites of five vegetation types consisting of $1^\circ \times 1^\circ$ areas surrounding weather stations were selected to examine the effects of rainfall on fire occurrence in different ecosystems. Five-month precipitation data from August to December, 1992 to 1996, were extracted to correlate with daily data of fire counts at the six stations. (See Appendix C)

2.4 GIS Software

IDRISI is a geographic information and image processing software developed at Clark University. It has become the largest raster, personal computer-based GIS and image processing system on the market since it was introduced in 1987. The early development of IDRISI was supported by the United Nations Environment Program Global Resource Information Database (UNEP/GRID), the United Nations Institute for Training and Research (UNITAR), and the United States Agency for International Development (USAID). It is widely used by many international development

agencies to provide access to low-cost geographic analytical tools in developing and underdeveloped countries.

Daily DMSP nighttime fire pixel data were processed and displayed using IDRISI Cartographic Display System. (See Appendix A, B) The issue of counting repeatedly the same fire pixels was examined by overlaying different days of fire maps. Six sites of five different vegetation types were selected to study the fire frequencies from early dry season to late dry season. Site selection was based on proximity to a weather station where daily rainfall could be compared to daily fire count. (See Appendix D)

3. Results

3.1 Locations of Fires

Nighttime daily DMSP fire images for 1993 and 1994 at the six selected $1^\circ \times 1^\circ$ grid cells showed that most fires occurred in grassland (Table 1). Figure 1 clearly shows that the two meadow or short grassland without woody cover areas had the highest fire occurrence for most of the season, followed by medium grassland without woody cover areas, and then followed by shrubland. There were more burning activities in tropical evergreen broadleaved forests than in grassland with shrub cover. Only a small number of fires were detected in grassland with shrub cover.

The fires occurred in grassland corresponding to the cattle grazing area in the Matthews' vegetation map. Fires in tropical evergreen broadleaved forests occurred mostly along the east coast where extensive subsistent cultivation of rice and tropical crops was located (Matthews, 1983). Therefore, fires in Madagascar were mainly used by humans to clear land for agriculture and grazing.

3.2 Seasonal Trend

The burning season in Madagascar lasts about five months (Hao and Liu, 1994). The number of fires detected by DMSP in all Madagascar and in the six selected $1^\circ \times 1^\circ$ grid cells from 1992 to 1996 suggested that burning activities in Madagascar started in August. October was the peak of the burning season except in 1994 and 1995 (Fig. 1; Table 2). The daily precipitation data indicated that October was relatively wet in 1994 (Figs. 2-7; Appendix C).

In both grassland and shrubland, October was the peak burning month in 1993. However, September was the peak burning month in both grassland without woody cover and shrubland in 1994. December was the peak of the burning months for both 1993 and 1994 in tropical evergreen broadleaved forests. It was interesting to note that two selected grid cells having the same vegetation of meadow/short grassland without woody cover showed the same seasonal burning pattern in 1993 (Fig. 1; Table 1).

3.3 Interannual Variation

Monthly total number of nighttime fires detected by the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) showed that there were increasing biomass burning activities from 1992 to 1996 in all Madagascar. The yearly total number of fires detected in Madagascar has increased about 30-40% during this period (Table 2; Fig. 8).

The government of Madagascar issued a “no burn” edict after August 31, 1994 in an attempt to reduce widespread biomass burning. Elvidge et al. (1996) presented a preliminary result which compared the nighttime fires detected with DMSP-OLS data on 20th of September 1992 and 1994. They suggested that the policy imposed by the government might have reduced the number of fires detected by comparing the DMSP-OLS images of these two days (Elvidge et al., 1996). Although Figure 8 shows slight reduction in total number of fires detected in 1994, the overall trend for the number of fires detected by DMSP-OLS shows increasing burning activities occurred in Madagascar from 1992 to 1996 (Fig. 8).

4. Conclusion

Nighttime DMSP daily images showed that burning activities were detected from August to December in Madagascar. The biomass burning activities in Madagascar have increased about 30-40% from 1993 to 1996. Most of the fires occurred in grassland, especially in grassland without woody cover. Annual precipitation affected the seasonality of biomass burning. The burning season usually peaked in October in both grassland and shrubland (Fig. 1). However, biomass burning activities peaked in December in tropical evergreen broadleaved forests. The farmers in Madagascar plant rice or tropical crops directly on freshly burned ashes. This might be the reason that most burning activities were observed after the raining season had started in November in tropical evergreen broadleaved forests, where extensive subsistence rice and tropical crops were grown. The burning activities seemed to peak in the middle of each month (Figs. 2-7), although this could not be explained with current data.

According to the FAO 1981 country report on tropical forests resources assessment, the dry season in Madagascar generally starts in May, and lasts until September. It varies in different regions. In the east coast of Madagascar, the dry season lasts from May to October. In the west coast of Madagascar, the dry season lasts longer in the southern region than in the northern region. In the central part of Madagascar, the dry season may last seven months. Although the time-series fire data from August 1 to December 31, 1992 to 1996, showed the seasonal pattern of biomass burning in Madagascar, we recommend that fire detection data for the entire year should be processed in the future.

5. Implication of Using DMSP-OLS for Future Research

Meteorological satellite sensors, such as the NOAA Advanced Very High Resolution Radiometer (AVHRR) and the Defense Meteorological Satellite Program Operational Linescan System (DMSP-OLS), were primarily designed to monitor global cloud distribution for weather prediction. Since meteorological satellite sensors can provide multiple daily coverage with great potential for real-time data retrieving at low cost, researchers have been actively developing and testing algorithms for detecting fires.

There are limitations to using DMSP-OLS data for fire detection. Fire detection is only effective with nighttime visible band data. Field observations, provided by Cochrane and Shultze (1998) indicated that groundfires in tropical forests tend to subside during the night in response to increases in air humidity. Therefore, this would decrease the probability of fire detection using DMSP-OLS which is limited to night time sensing. Prins and Menzel (1994) also concluded that the peak burning in the Amazon occurred in the afternoon. Fire pixel counts dropped substantially as darkness fell, as measured using high temporal frequency of the GOES satellite data. Direct comparisons of nighttime DMSP-OLS versus mid-afternoon GOES fire products showed that DMSP-OLS typically detected fewer fires in forest areas. Cahoon et al. (1992) also compared the night time fire frequency and the distribution of fires with those mapped during daytime. They suggested that a large number of fires continued to burn into the night. Therefore, fire detection might not be as strongly diurnal as commonly believed. However, fires that did not continue burning into the night would be missed by DMSP-OLS.

A recent research on wildfire detection was conducted at the Gila National Forest and Wilderness area in New Mexico during a two-week test period of June 3, 1996 to June 18, 1996. The objective was to assess and compare the capability of different meteorological satellite sensors for fire detection. The satellite sensors include NOAA-Advanced Very High Resolution Radiometer (AVHRR), the NOAA Geostationary Operational Environmental Satellite (GOES) and the Defense Meteorological Satellite Program Operational Linescan System (DMSP-OLS). In addition to the satellite data, the archived fire reports at the Gila National Forest were used for comparison with satellite fire detection results. The results from comparison of three satellite sensors in this experiment indicated that GOES data had the lowest fire detection success rate of about 22%. The success rate using AVHRR is 37.5%. DMSP-OLS had the highest fire detection success rate of 66.7%. The smallest fire detected by DMSP and GOES had a burned area of 5 acres, while the smallest fire detected by AVHRR had a size of 30 acres (Elvidge et al., 1997). Elvidge et al. (1999) developed a calibration technique to locate and estimate the area of heavy forests burning in Brazil based on the frequency of fires detected by DMSP-OLS from the time series of observations across the fire season. This calibration was developed using Landsat TM data acquired near the end of the 1998 burning season to analyze and identify unburned, partially burned, and heavily burned forests. A fire detection frequency threshold of five nights was used to map heavily burned forests using the DMSP-OLS observations from January 1 through March 11, for the years of 1995 and 1998. The 1995 data were processed to provide a comparison between the extreme fire events of 1998 and a typical year in terms of precipitation. The DMSP-OLS estimate of heavily burned forest area covered 79% of the Landsat measured area. It underestimated the area of heavy forest burning by 21% in 1998. The DMSP estimate of heavily burned forest area is 77% of the statewide estimates based on airborne missions and intensive field work by the Instituto Nacional de Pesquisas Amazonas (INPA). There was also a close correspondence between the estimates of the area for unburned and partially burned tropical forests between Landsat and DMSP-OLS data.

One of the major uncertainties in estimating the emissions of greenhouse gases and particulate matter globally is to quantify the amount of biomass burned. It is important to develop a methodology to estimate the burned area using satellite data. Some research has been conducted

using LANDSAT data to develop applicable calibrations of burned area for AVHRR fire observations regionally (Scholes et al., 1994). It may be necessary to use data from more than one satellite for fire detection.

6. References

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Table 1. Number of Monthly Nighttime Fires Detected by DMSP-OLS in Selected 1° x 1° Grid Cells of Different Vegetation Types
(August – December, 1993 – 1994)

	Weather Station Location	(16.75 S, 44.48 E)	(16.95 S, 46.83 E)	(18.80 S, 47.48 E)	(19.82 S, 47.07 E)	(21.20 S, 48.37 E)	(25.03 S, 46.95 E)
	Vegetation Type	Tall/Medium/Short Grassland (with shrub cover)	Medium Grassland (without woody cover)	Meadow/ Short Grassland (without woody cover)	Meadow/ Short Grassland (without woody cover)	Tropical Evergreen Broadleaved Forest	Shrubland
1993	August	39	2,161	1,635	1,125	139	270
	September	317	2,972	8,100	4,511	49	1,613
	October	328	6,394	14,822	8,295	856	3,428
	November	182	2,613	2,589	1,277	630	1,113
	December	89	1,736	3,131	1,297	2,947	642
	Total	955	15,876	30,277	16,505	4,621	7,066
1994	August	102	2,736	4,024	956	136	894
	September	181	7,856	11,774	2,474	472	1,977
	October	371	3,397	7,022	2,591	744	1,253
	November	198	2,288	6,377	3,894	929	1,151
	December	61	477	869	205	2,599	505
	Total	913	16,754	30,066	10,120	4,880	5,780

Table 2. Total Number of Monthly Nighttime Fires Detected by DMSP-OLS in all of Madagascar from 1992 to 1996 (in Thousands)

	1992	1993	1994	1995	1996
August		101	160	264	231
September	187	165	275	309	285
October	300	327	148	294	343
November	25	119	121	162	218
December	80	80	41	4	24
Totals:		792	745	1,033	1,101

* The data for August 1992 were removed because of the poor quality of data.

**Fig. 1 Monthly total No. of Fires Detected in Different Vegetation Types
(August - December, 1993 - 1994)**

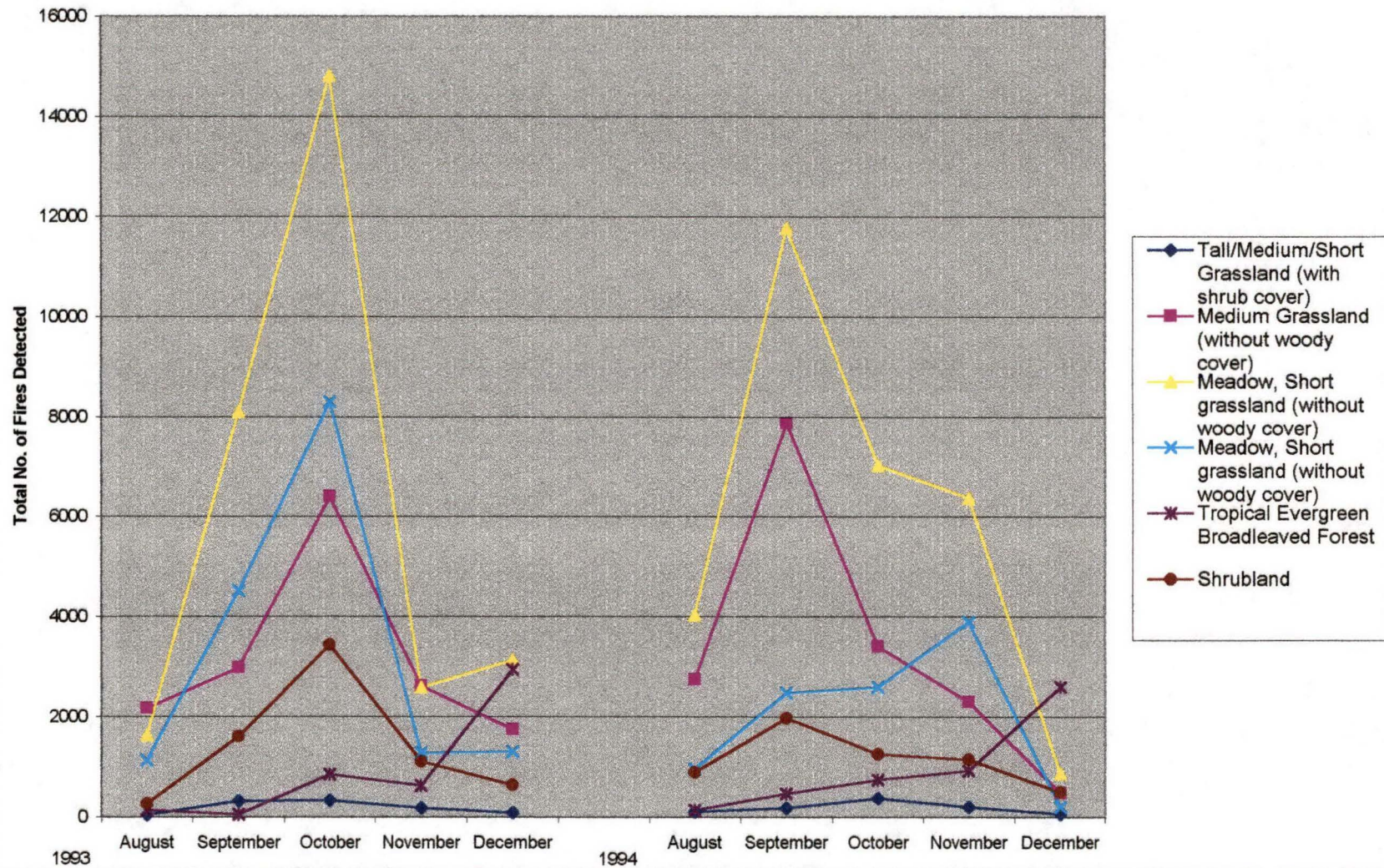


Fig. 2 Daily Precipitation (in mm) and Fire Counts in Tall/Medium/Short Grassland with Shrub Cover at Selected 1° X 1° Grid Cell, Madagascar (August 1 - December 31, 1993 - 1994)

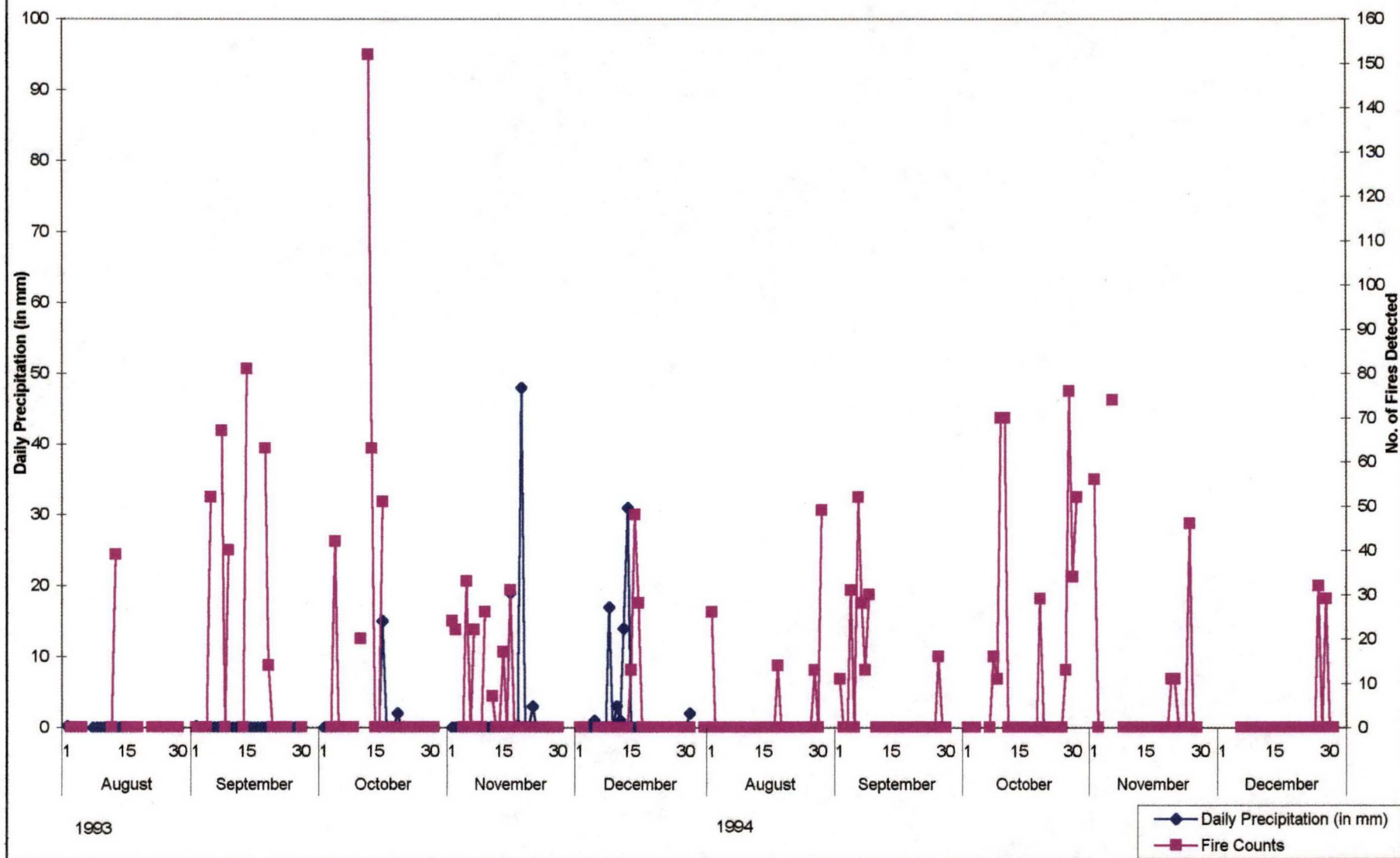


Fig. 3 Daily Precipitation (in mm) and Fire Counts in Medium Grassland without Woody Cover at Selected 1° X 1° Grid Cell, Madagascar (August 1 - December 31, 1993 - 1994)

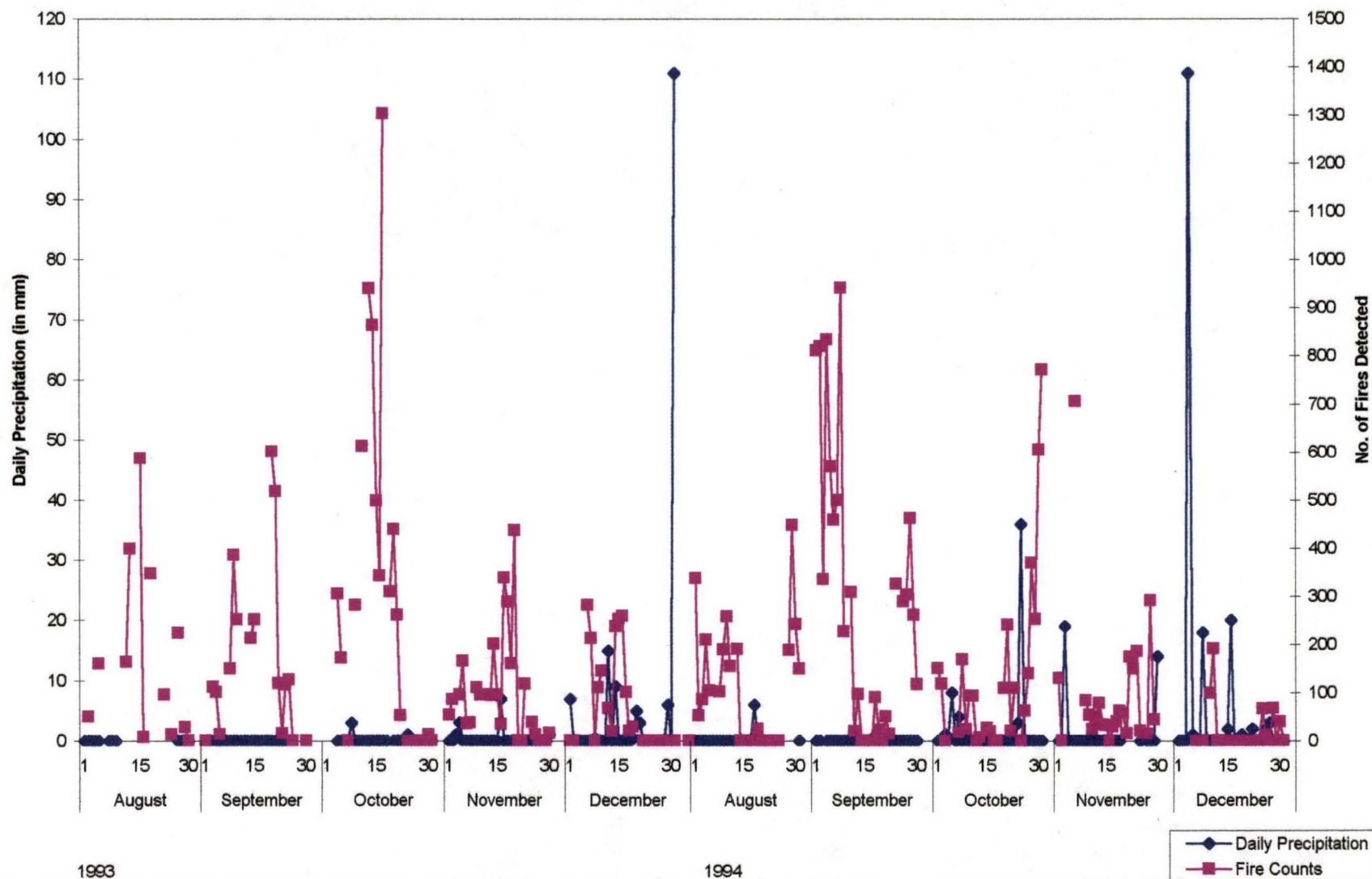


Fig. 4 Daily Precipitation (in mm) and Fire Counts in Meadow, Short Grassland without Woody Cover at Selected 1° X 1° Grid Cell, Madagascar (August 1 - December 31, 1993 - 1994)

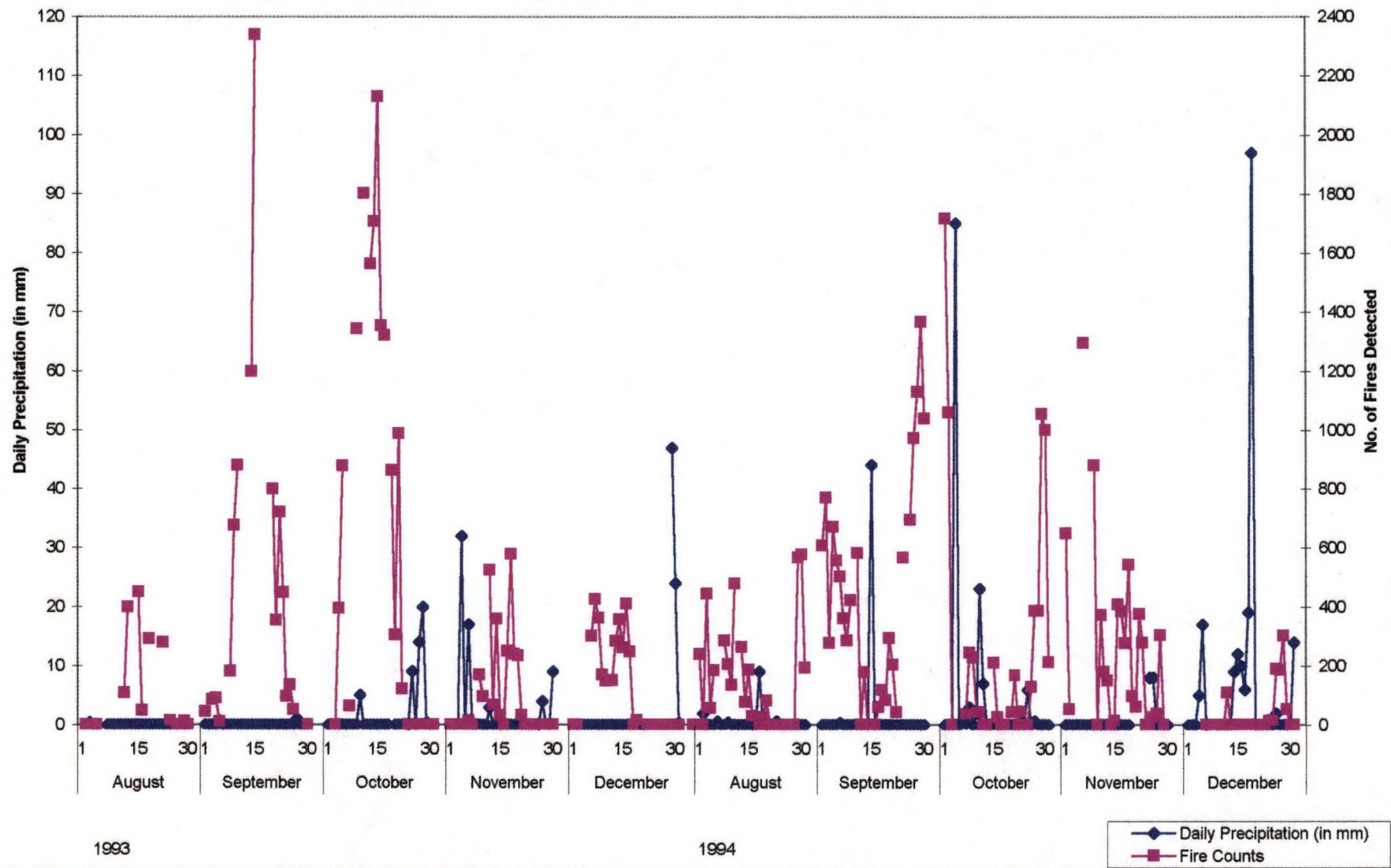


Fig. 5 Daily Precipitation (in mm) and Fire Counts in Meadow, Short Grassland without Woody Cover at Selected 1° X 1° Grid Cell, Madagascar (August 1 - December 31, 1993 - 1994)

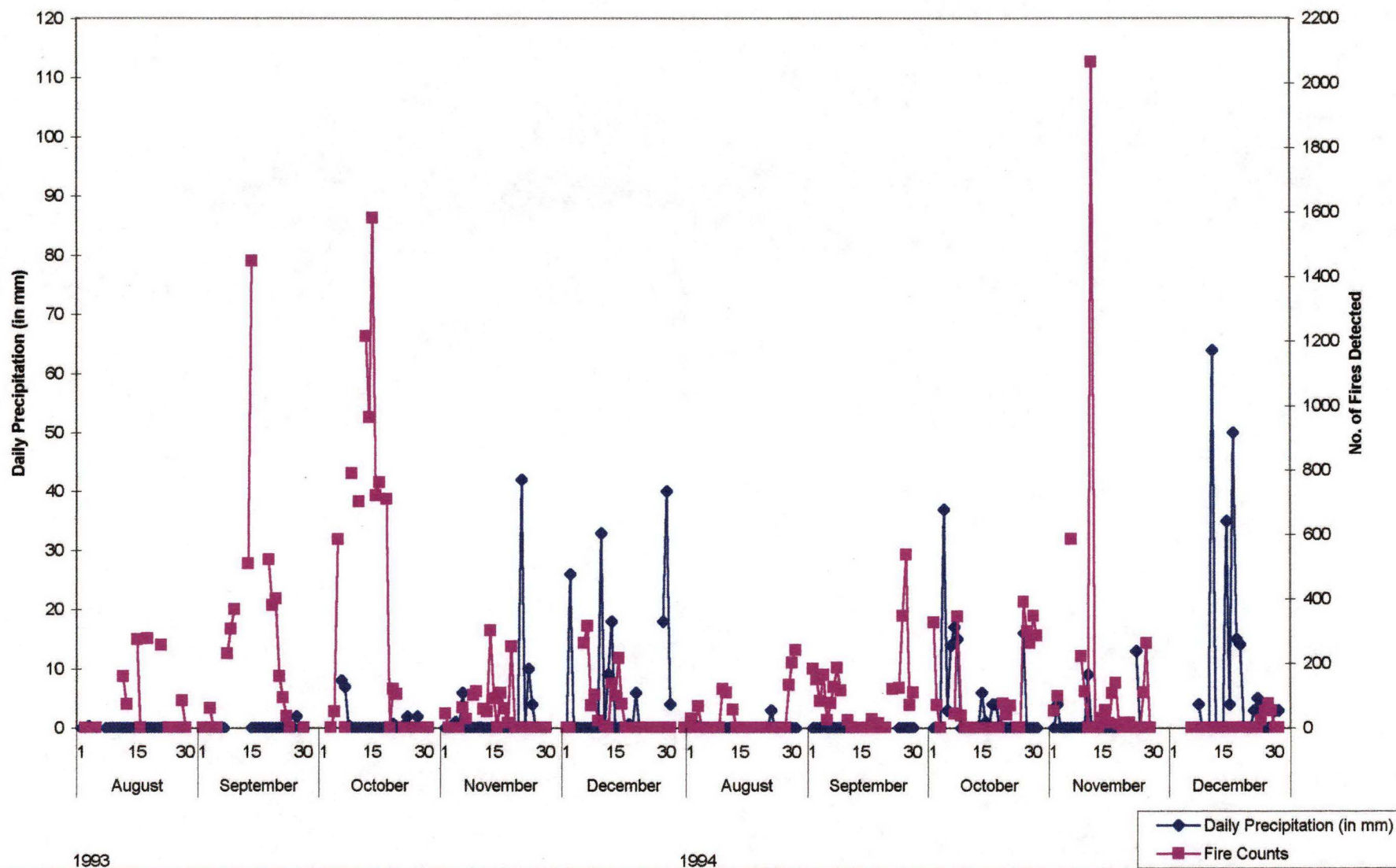


Fig. 6 Daily Precipitation (in mm) and Fire Counts in Tropical Evergreen broadleaved Forest at Selected 1° X 1° Grid Cell, Madagascar (August 1 - December 31, 1993 - 1994)

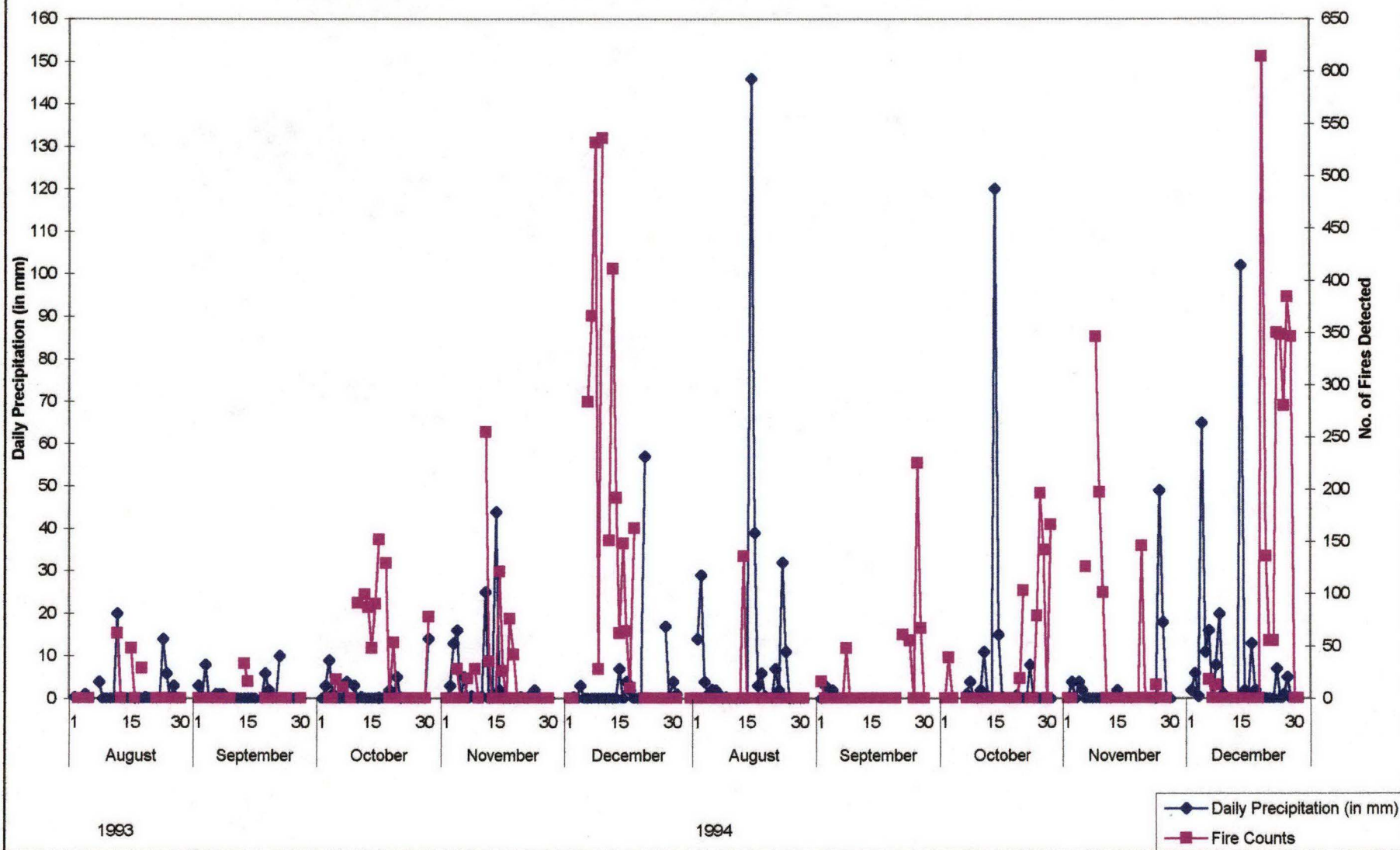


**Fig. 7 Daily Precipitation (in mm) and Fire Counts in Shrubland at Selected 1° X 1° Grid Cell
Madagascar (August 1 - December 31, 1993 - 1994)**

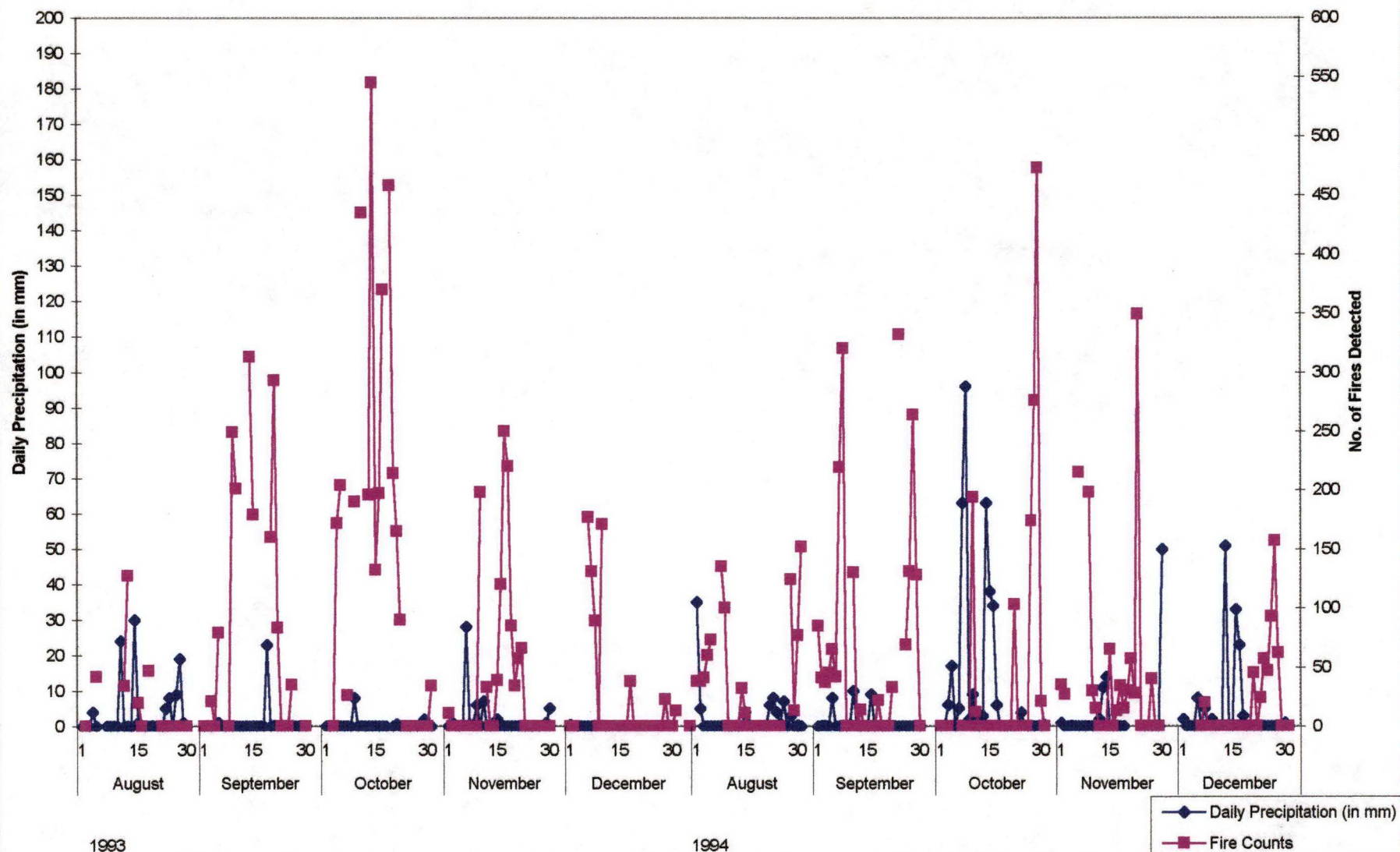
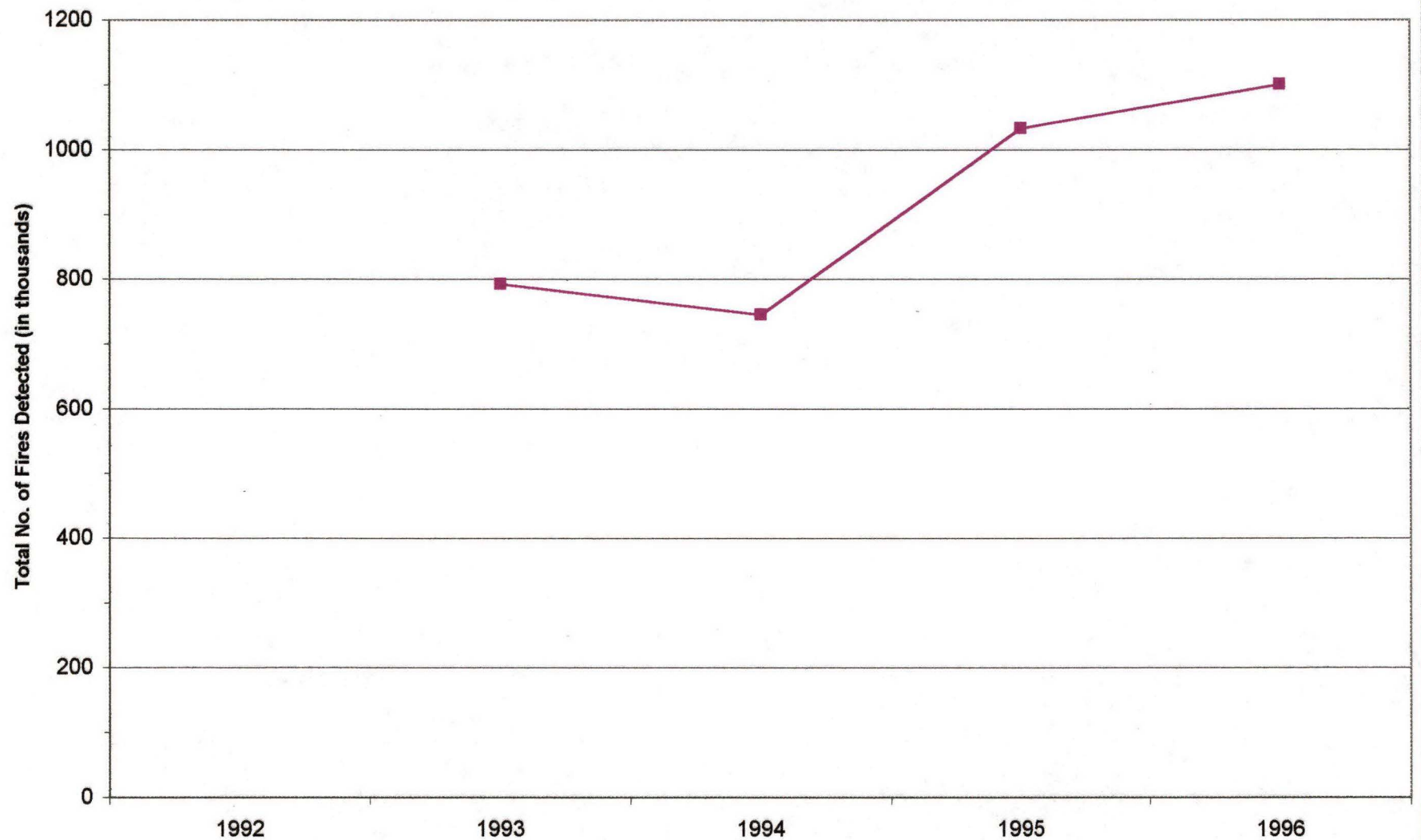


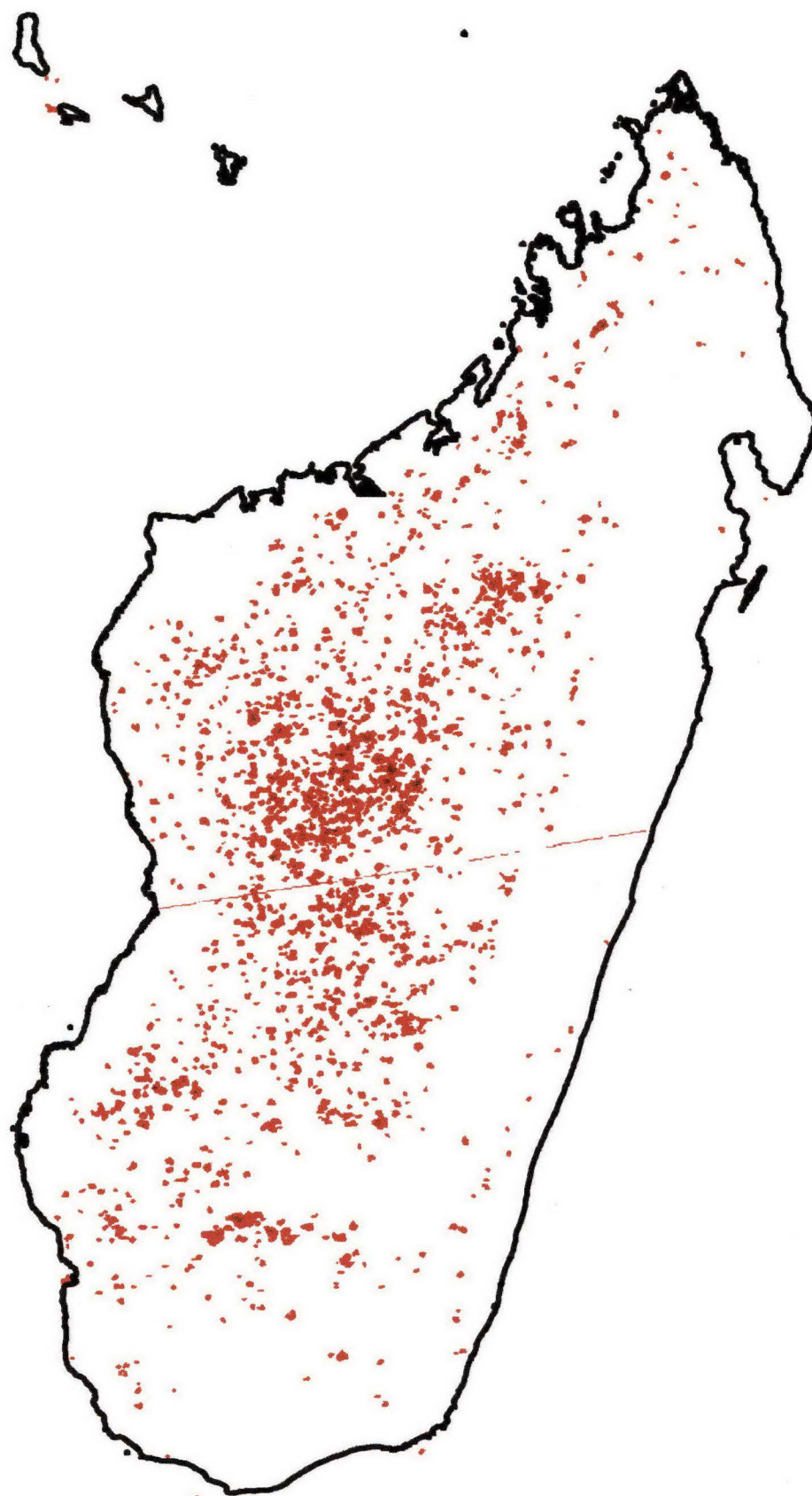
**Fig. 8 Total No. of Fires Detected by DMSP-OLS in Madagascar
(August 1 - December 31, 1992 - 1996)**



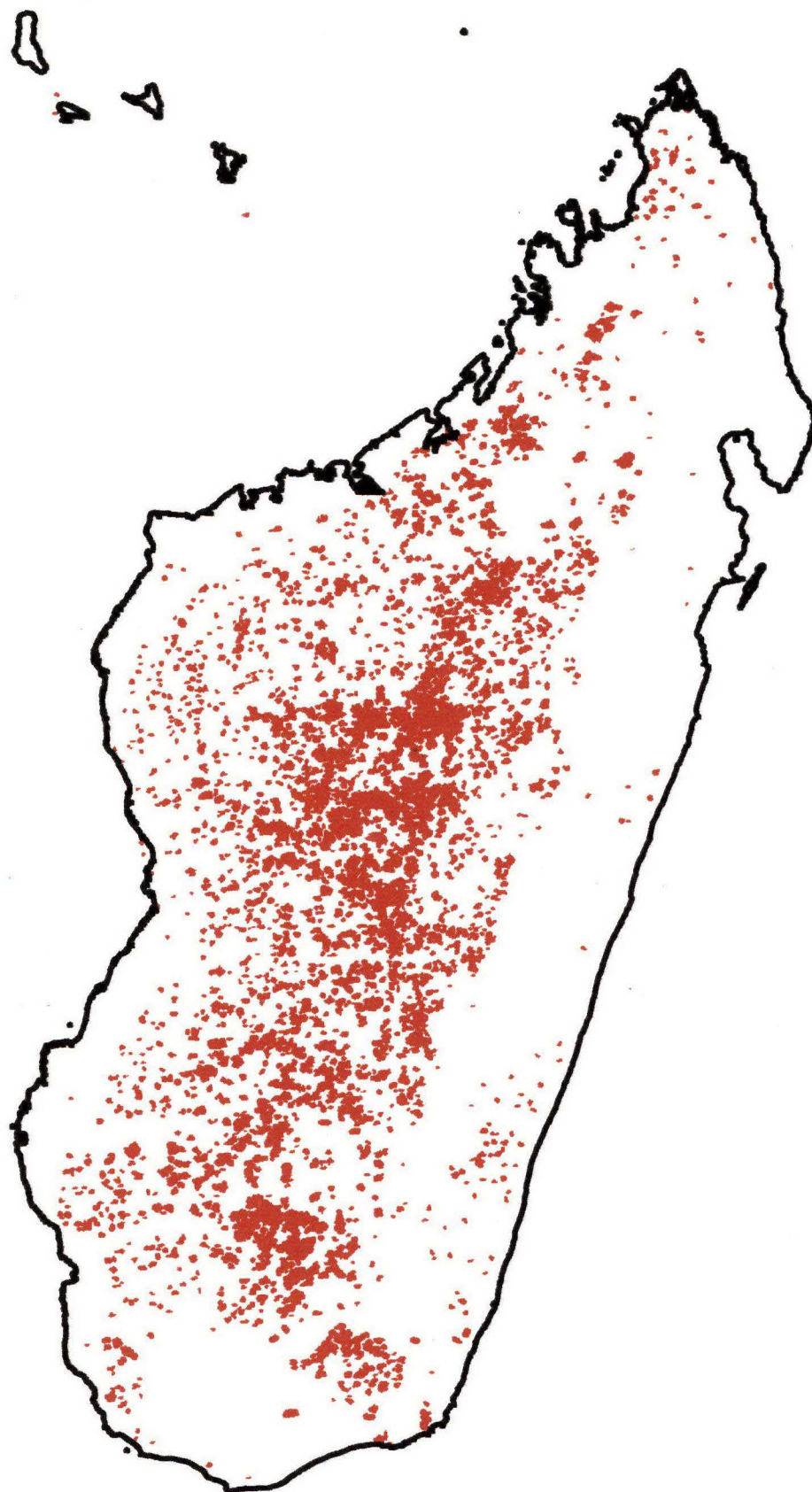
Appendix A. Monthly Total Number of Fires Detected by 1° Longitude, Madagascar, 1993

1993 Monthly Fire Detected	43E-44E	44E-45E	45E-46E	46E-47E	47E-48E	48E-49E	49E-50E	50E-51E
August	847	6,729	16,413	20,534	8,254	2,477	512	25
September	909	11,122	31,815	40,943	23,933	6,357	1,179	26
October	810	14,154	33,464	54,952	37,621	19,651	3,030	87
November	1,158	15,029	19,628	28,096	15,861	6,348	4,265	165
December	332	2,411	3,239	9,711	20,228	15,985	10,431	814

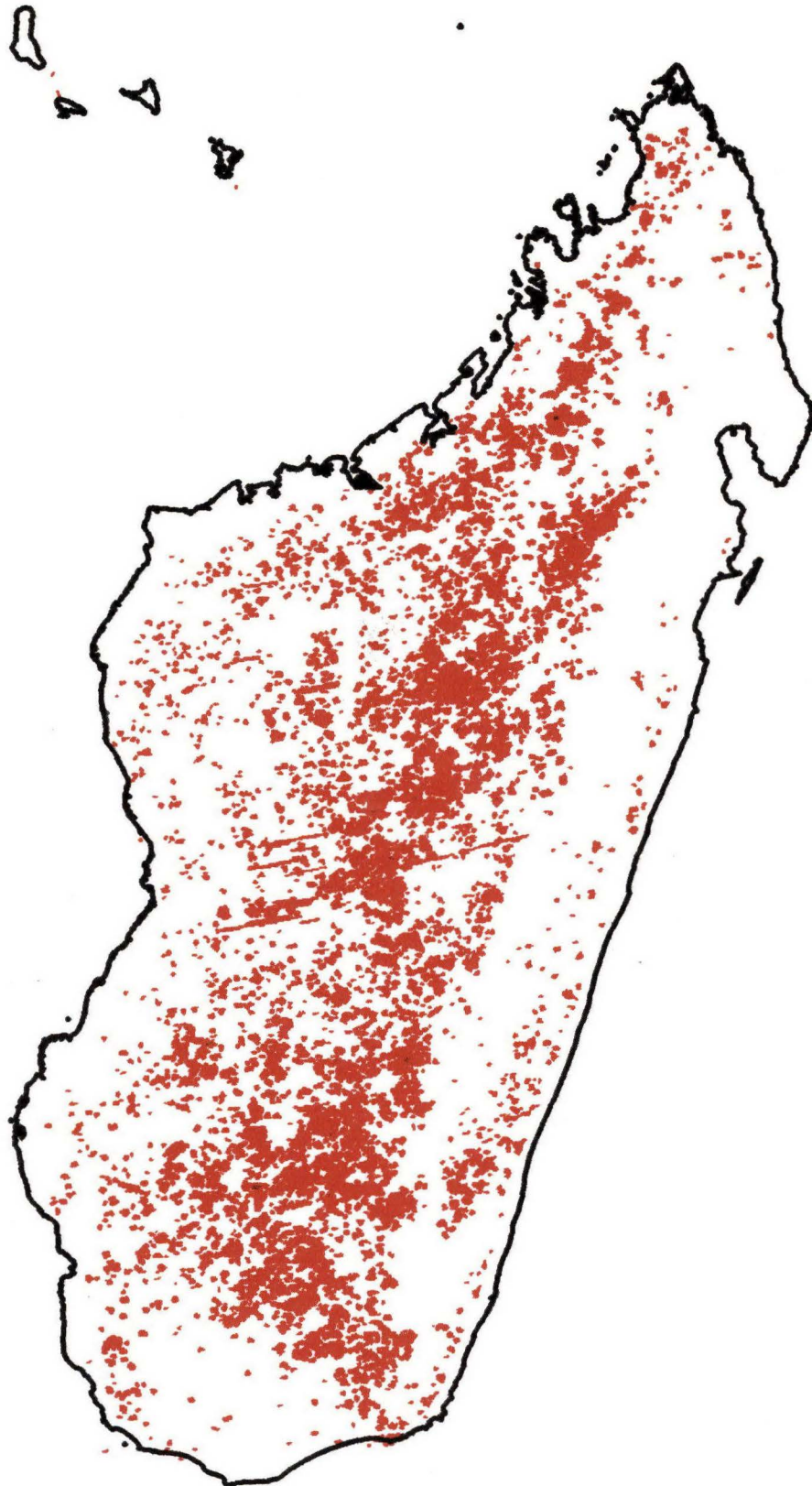
Total No. of Fires Detected in Madagascar, August, 1993



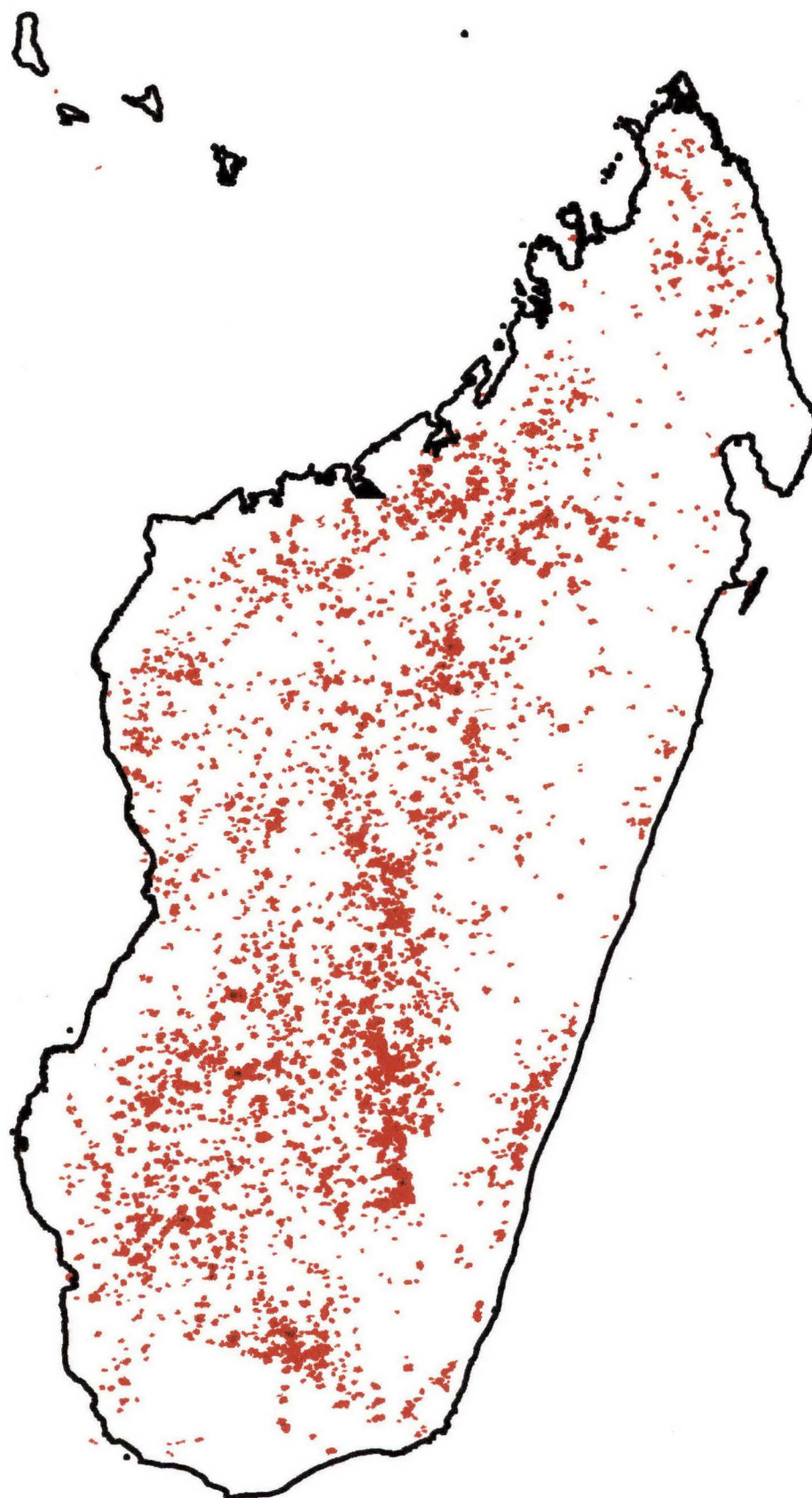
Total No. of Fires Detected in Madagascar, September, 1993



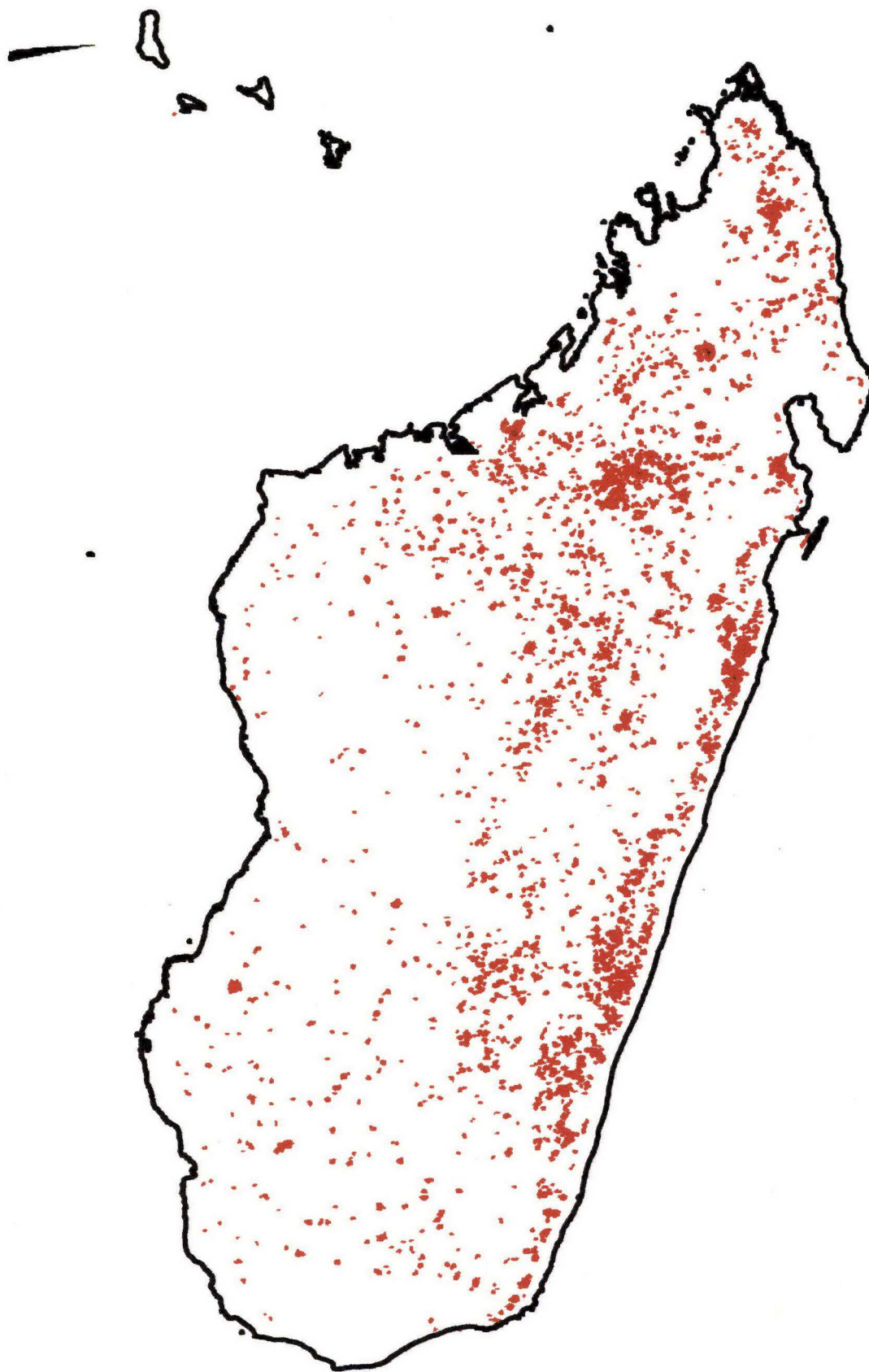
Total No. of Fires Detected in Madagascar, October, 1993



Total No. of Fires Detected in Madagascar, November, 1993



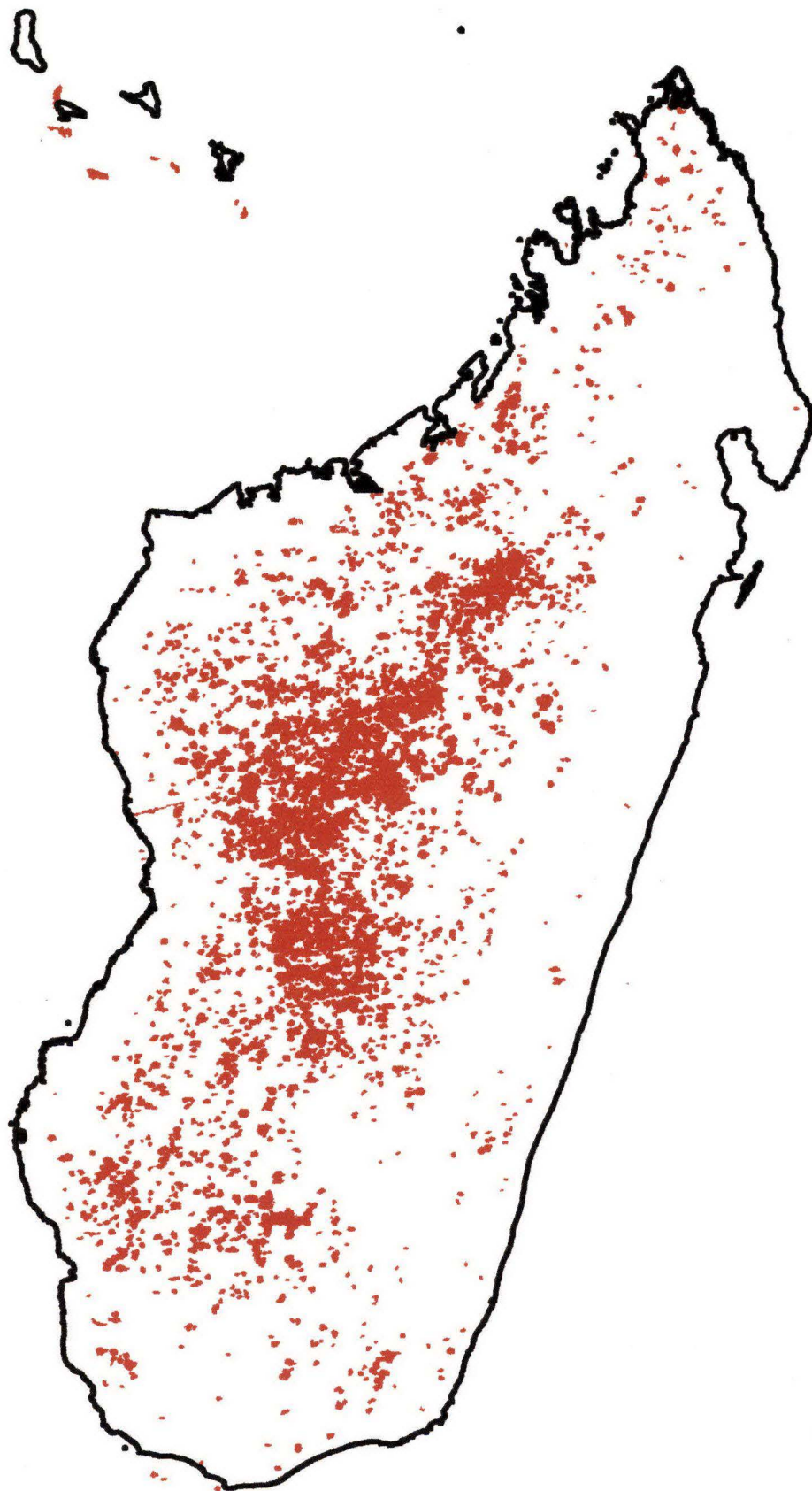
Total No. of Fires Detected in Madagascar, December, 1993



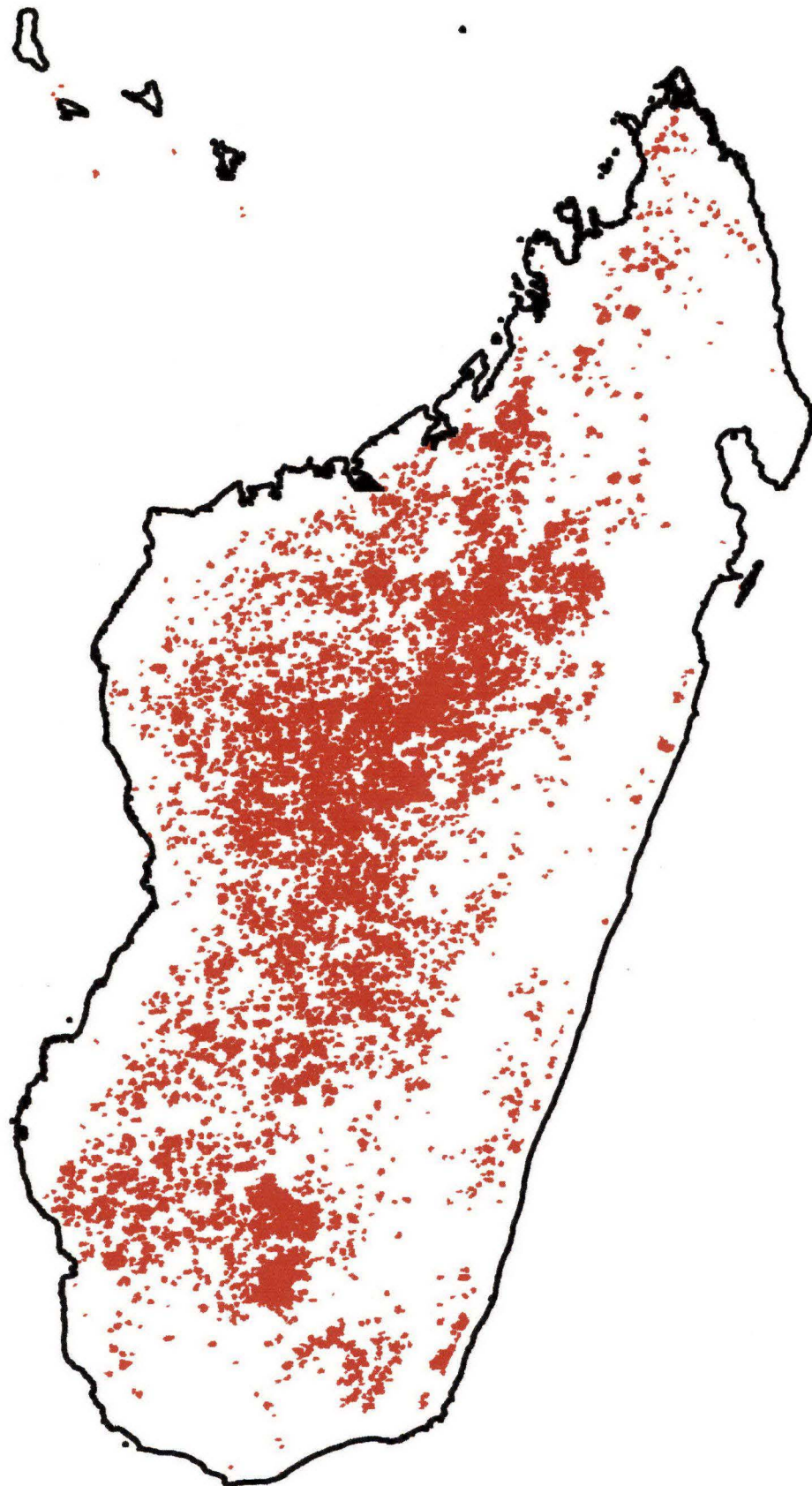
Appendix B. Monthly Total Number of Fires Detected by 1° Longitude, Madagascar, 1994

1994 Monthly Fire Detected	43E-44E	44E-45E	45E-46E	46E-47E	47E-48E	48E-49E	49E-50E	50E-51E
August	1,590	13,328	33,837	34,114	17,509	4,319	1,287	13
September	2,541	20,057	48,100	48,676	33,095	11,985	2,531	26
October	1,013	11,344	15,533	27,066	20,894	10,291	2,168	0
November	752	6,763	8,440	15,186	13,255	13,344	6,207	164
December	380	1,581	2,213	3,367	9,868	11,290	4,116	95

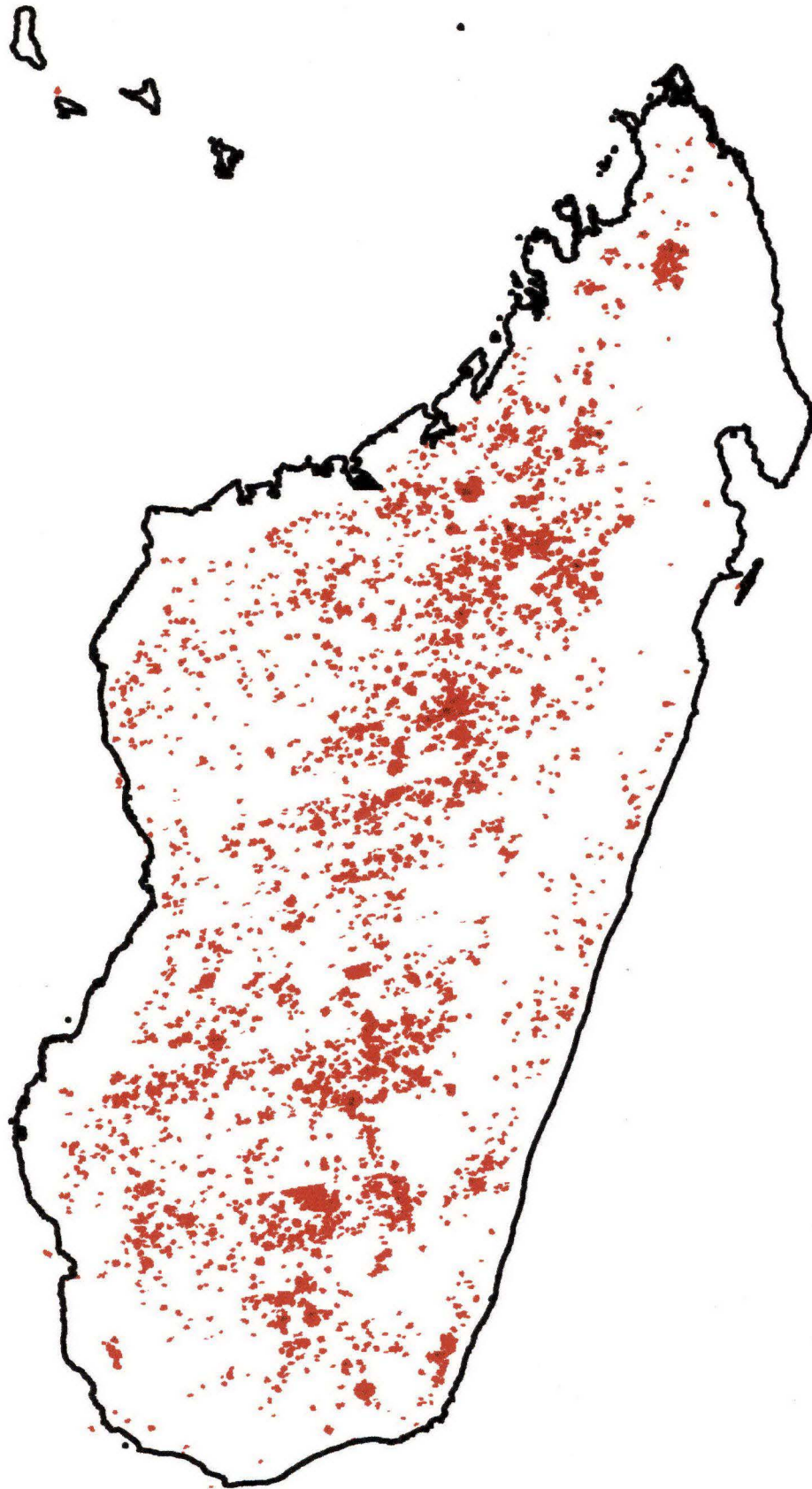
Total No. of Fires Detected in Madagascar, August, 1994



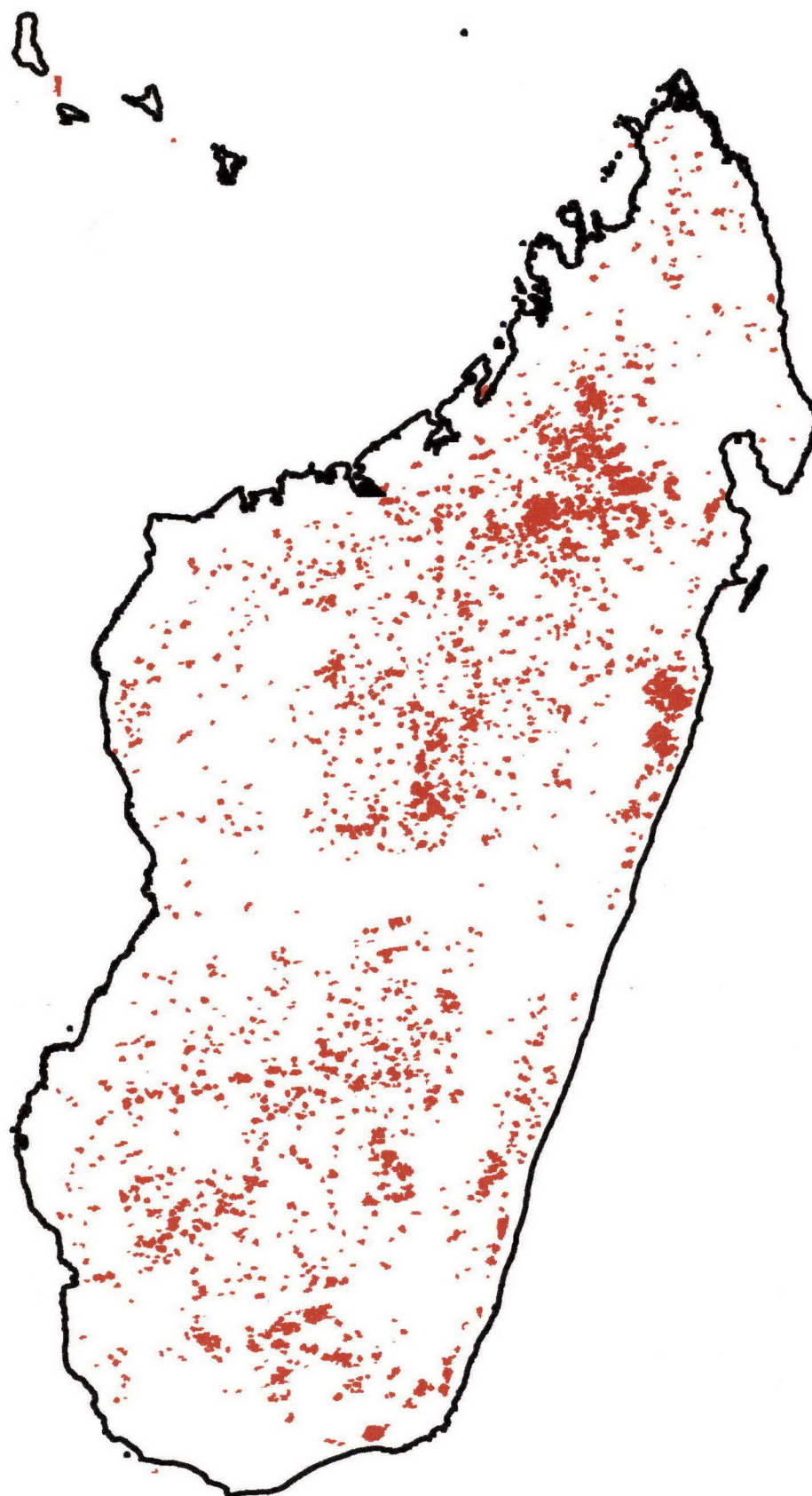
Total No. of Fires Detected in Madagascar, September, 1994



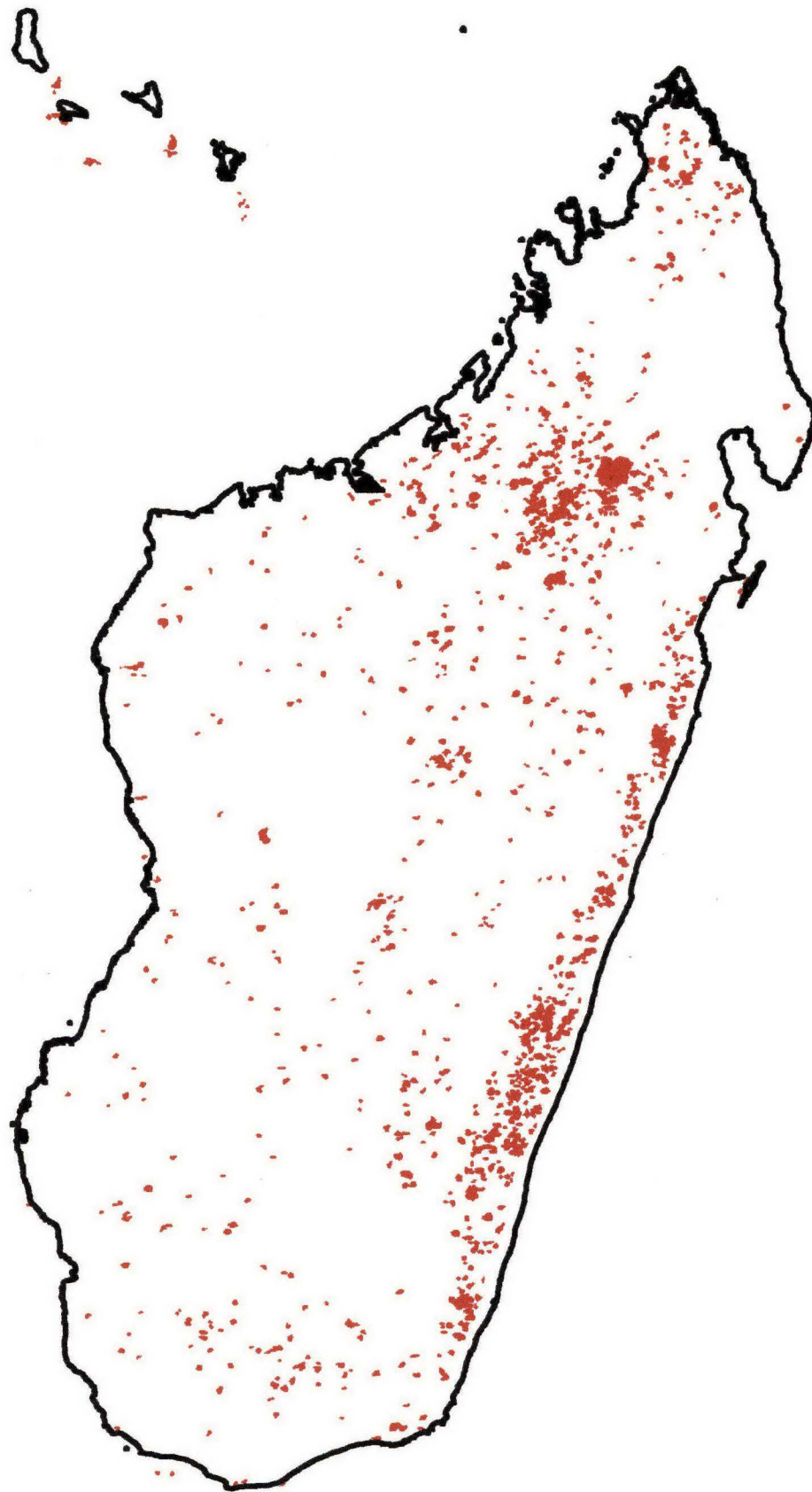
Total No. of Fires Detected in Madagascar, October, 1994



Total No. of Fires Detected in Madagascar, November, 1994



Total No. of Fires Detected in Madagascar, December, 1994



Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

Station: 67037
(-16.75,44.48)
Vegtype: P

Station: 67045
(-16.95,46.83)
Vegtype: R

Daily Precipitation (in mm) Fire Counts			Daily Precipitation (in mm) Fire Counts		
1993 August			1993 August		
19930801	1	0.2	19930801	1	0
19930802		0	19930802		0 50
19930803		0	19930803		0
19930804		0	19930804		0
19930805		0	19930805		0 160
19930806		0	19930806		0
19930807		0	19930807		0
19930808		0	19930808		0
19930809		0	19930809		
19930810		0	19930810		
19930811		0	0 19930811		163
19930812		0	39 19930812		399
19930813		0	19930813		
19930814		0	19930814		
19930815	15	0	0 19930815	15	587
19930816		0	0 19930816		8
19930817		0	19930817		
19930818			0 19930818		347
19930819			19930819		
19930820			19930820		
19930821			19930821		
19930822			0 19930822		96
19930823			19930823		
19930824			0 19930824		13
19930825			19930825		
19930826			0 19930826		0 224
19930827			19930827		0
19930828			0 19930828		0 28
19930830	30	0	0 19930830	30	0 0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

September			September				
19930901	1	0.2	0	19930901	1	0	0
19930902		0		19930902		0	
19930903		0	0	19930903		0	112
19930904		0	0	19930904		0	101
19930905		0	52	19930905		0	13
19930906		0		19930906		0	
19930907		0		19930907		0	
19930908		0	67	19930908		0	149
19930909		0	0	19930909		0	386
19930910		0	40	19930910		0	251
19930911		0		19930911		0	
19930912		0		19930912		0	
19930913		0		19930913		0	
19930914		0	0	19930914		0	213
19930915	15	0	81	19930915	15	0	251
19930916		0		19930916		0	
19930917		0		19930917		0	
19930918		0		19930918		0	
19930919		0		19930919		0	
19930920		0	63	19930920		0	601
19930921		0	14	19930921		0	518
19930922		0	0	19930922		0	119
19930923		0	0	19930923		0	15
19930924		0	0	19930924		0	116
19930925		0	0				127
19930926		0	0				0
19930927		0					
19930928		0					
19930929		0					
19930930	30	0	0		30		0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

October			October		
19931001	1	0	19931001	1	0
19931002		0	19931002		0
19931003		0	19931003		0
19931004		0	19931004		0
19931005		42	19931005		0
19931006		0	19931006		0
19931007		0	19931007		0
19931008		0	19931008		3
19931009		0	19931009		0
19931010		0	19931010		0
19931011		20	19931011		0
19931012		0	19931012		0
19931013		152	19931013		0
19931014		63	19931014		0
19931015	15	0	19931015	15	0
19931016		0	19931016		0
19931017		15	19931017		0
19931018		0	19931018		0
19931019		0	19931019		0
19931020		0	19931020		0
19931021		2	19931021		0
19931022		0	19931022		0
19931023		0	19931023		0
19931024		0	19931024		1
19931025		0	19931025		0
19931026		0	19931026		0
19931027		0	19931027		0
19931028		0	19931028		0
19931029		0	19931029		0
19931030	30	0	19931030	30	0
19931031		0	19931031		0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1993 November			1993 November		
19931101	1	0	24 19931101	1	0
19931102		0	22 19931102		0
19931103		0	19931103		1
19931104		0	0 19931104		3
19931105		0	33 19931105		0
19931106		0	0 19931106		0
19931107		0	22 19931107		0
19931108		0	19931108		0
19931109		0	0 19931109		0
19931110		0	26 19931110		0
19931111		0	19931111		0
19931112		0	7 19931112		0
19931113		0	0 19931113		0
19931114		0	0 19931114		0
19931115	15	0	17 19931115	15	0
19931116		0	0 19931116		7
19931117		19	31 19931117		0
19931118		0	0 19931118		0
19931119		0.3	0 19931119		0
19931120		48	0 19931120		0
19931121		0	0 19931121		0
19931122		0	0 19931122		0
19931123		3	0 19931123		0
19931124		0	19931124		0
19931125		0	0 19931125		0
19931126		0	0 19931126		0
19931127		0	0 19931127		0
19931128			0 19931128		0
19931129		0	0 19931129		0
19931130	30	0	0 19931130	30	1
					16

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1993 December			1993 December		
19931201	1	0	19931201	1	7
19931202		0	19931202		0
19931203		0	19931203		0
19931204		0	19931204		0
19931205		1	19931205		0
19931206		0	19931206		0
19931207		0	19931207		0
19931208		0	19931208		0.4
19931209		17	19931209		0
19931210		0	19931210		0
19931211		3	19931211		0
19931212		1	19931212		15
19931213		14	19931213		0
19931214		31	19931214		9
19931215	15	0	19931215	15	0
19931216		0	19931216		0
19931217		0	19931217		0
19931218		0	19931218		0
19931219		0	19931219		0.4
19931220		0	19931220		5
19931221		0	19931221		3
19931222		0	19931222		0
19931223			19931223		0
19931224			19931224		0
19931225			19931225		0
19931226			19931226		0
19931227			19931227		0
19931228			19931228		0
19931229		0	19931229		6
19931230	30	0	19931230	30	0
19931231		2	19931231		111

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 August			1994 August		
	Daily Precipitation (in mm)	Fire Counts		Daily Precipitation (in mm)	Fire Counts
19940801	1	26	19940801	0	337
19940802		0	19940802	0	53
19940803		0	19940803	0	86
19940804		0	19940804	0	210
19940805		0	19940805	0	104
19940806		19940806		0	
19940807		19940807		0	
19940808		0	19940808	0	102
19940809		0	19940809	0	189
19940810		0	19940810	0	258
19940811		0	19940811	0	155
19940812		19940812		0	
19940813		0	19940813	0	190
19940814		0	19940814	0	0
19940815	15	0	19940815	0.1	0
19940816		0	19940816	0	0
19940817		19940817		0	
19940818		0	19940818	6	0
19940819		14	19940819	0	25
19940820		0	19940820	0	0
19940821		0	19940821	0	0
19940822		0	19940822	0	0
19940823		0	19940823	0	0
19940824		0	19940824	0	0
19940825		0	19940825		0
19940826		19940826			
19940827		19940827			
19940828		0	19940828		188
19940829		13	19940829		448
19940830	30	0	19940830		242
19940831		49	19940831	0	149

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 September		1994 September			
19940901	1	11 19940901	1	0	811
19940902		0 19940902		0	820
19940903		0 19940903			335
19940904		31 19940904		0	834
19940905		0 19940905		0	569
19940906		52 19940906		0	459
19940907		28 19940907		0	500
19940908		13 19940908		0	941
19940909		30 19940909		0	227
19940910		19940910		0	
19940911		0 19940911		0	308
19940912		0 19940912		0	19
19940913		0 19940913		0	97
19940914		0 19940914		0	0
19940915	15	0 19940915	15	0	0
19940916		0 19940916		0	0
19940917		0 19940917		0.4	0
19940918		0 19940918		0	90
19940919		0 19940919		0	23
19940920		0 19940920		0	0
19940921		0 19940921		0	51
19940922		0 19940922		0	14
19940923		19940923		0	
19940924		0 19940924		0	326
19940925		19940925		0	
19940926		0 19940926		0	289
19940927		0 19940927		0	303
19940928		16 19940928		0	462
19940929		0 19940929		0	261
19940930	30	0 19940930	30	0	117

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 October		1994 October			
19941001	1	0 19941001	1	0	150
19941002		0 19941002		0	118
19941003		0 19941003		1	0
19941004		19941004		0.6	
19941005		19941005		8	
19941006		19941006		0	
19941007		0 19941007		4	17
19941008		16 19941008		0	169
19941009		11 19941009		0	24
19941010		70 19941010		0	93
19941011		70 19941011		0	93
19941012		0 19941012		0	0
19941013		0 19941013		0	6
19941014		19941014		0	
19941015	15	0 19941015	15	0	27
19941016		0 19941016		0	19
19941017		0 19941017		0	0
19941018		0 19941018		0	0
19941019		19941019		0	
19941020		0 19941020		0	110
19941021		29 19941021		0	241
19941022		0 19941022		0	20
19941023		0 19941023		0	110
19941024		19941024		3	
19941025		0 19941025		36	0
19941026		0 19941026		0	62
19941027		0 19941027		0	140
19941028		13 19941028		0	370
19941029		76 19941029		0	252
19941030	30	34 19941030	30	0	605
19941031		52 19941031		0	771

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 November		1994 November			
19941101	1	56 19941101	1	0	130
19941102		0 19941102		0	0
19941103		19941103		19	
19941104		19941104		0	
19941105		19941105		0	
19941106		74 19941106		0	706
19941107		19941107		0	
19941108		19941108		0	
19941109		0 19941109		0	84
19941110		0 19941110		0	54
19941111		0 19941111		0	24
19941112		0 19941112		0	50
19941113		0 19941113		0	78
19941114		0 19941114		0	33
19941115	15	0 19941115	15	0	32
19941116		0 19941116		0	0
19941117		0 19941117		0	29
19941118		0 19941118		0	40
19941119		0 19941119		0	62
19941120		0 19941120			58
19941121		0 19941121			15
19941122		11 19941122			174
19941123		11 19941123			149
19941124		0 19941124			186
19941125		0 19941125		0	20
19941126		0 19941126		1	15
19941127		46 19941127		0	14
19941128		0 19941128		0	291
19941129		0 19941129		0	44
19941130	30	19941130	30	14	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 December		1994 December		1994 December	
19941201	1	19941201	1	0	
19941202		19941202		0	
19941203		19941203		0	
19941204		19941204		111	
19941205		19941205		1	
19941206		0 19941206		0	0
19941207		0 19941207		0	0
19941208		0 19941208		18	0
19941209		19941209		0	
19941210		0 19941210		0	99
19941211		0 19941211		0	191
19941212		0 19941212		0	0
19941213		0 19941213		0	0
19941214		0 19941214		0	0
19941215	15	0 19941215	15	2	0
19941216		0 19941216		20	0
19941217		0 19941217		0	0
19941218		0 19941218		0	0
19941219		0 19941219		1	0
19941220		0 19941220		0	0
19941221		0 19941221		0.3	0
19941222		0 19941222		2	0
19941223		0 19941223		0	0
19941224		0 19941224		0	0
19941225		0 19941225		0	67
19941226		0 19941226		2	12
19941227		32 19941227		3	0
19941228		0 19941228		0	68
19941229		29 19941229		0	0
19941230	30	0 19941230	30	0	40
19941231		0 19941231		0	0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1995 Daily Precipitation (In mm)			1995 Daily Precipitation (In mm)		
August	0		August	0	
19950801	1	0	19950801	1	0
19950802	2	0	19950802	2	0
19950803	3	0	19950803	3	0
19950804	4	0	19950804	4	0
19950805	5	0	19950805	5	0
19950806	6	0	19950806	6	0
19950807	7	0	19950807	7	0
19950808	8	0	19950808	8	0
19950809	9	0	19950809	9	0
19950810	10	0	19950810	10	0
19950811	11	0	19950811	11	0
19950812	12	0	19950812	12	0
19950813	13	0	19950813	13	0
19950814	14		19950814	14	
19950815	15		19950815	15	
19950816	16	0	19950816	16	0
19950817	17	0	19950817	17	0
19950818	18	0	19950818	18	0
19950819	19	0	19950819	19	0
19950820	20	0	19950820	20	
19950821	21	0	19950821	21	
19950822	22		19950822	22	
19950823	23		19950823	23	
19950824	24		19950824	24	
19950825	25		19950825	25	
19950826	26		19950826	26	
19950827	27		19950827	27	
19950828	28		19950828	28	
19950829	29		19950829	29	
19950830	30		19950830	30	
19950831	31		19950831	31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

September	0		September	0	
19950901	1		19950901	1	
19950902	2		19950902	2	
19950903	3		19950903	3	
19950904	4	0	19950904	4	
19950905	5	0	19950905	5	0
19950906	6	0	19950906	6	0
19950907	7	0	19950907	7	0
19950908	8	0	19950908	8	3
19950909	9	0	19950909	9	0
19950910	10	0	19950910	10	0
19950911	11	0	19950911	11	0
19950912	12	0	19950912	12	0
19950913	13	0	19950913	13	0
19950914	14	0	19950914	14	0
19950915	15	0	19950915	15	0
19950916	16	0	19950916	16	0
19950917	17	0	19950917	17	0
19950918	18	0	19950918	18	0
19950919	19	0	19950919	19	0
19950920	20	0	19950920	20	0
19950921	21	1	19950921	21	0
19950922	22	0	19950922	22	0
19950923	23	0	19950923	23	0
19950924	24	0	19950924	24	0
19950925	25	0	19950925	25	0
19950926	26	0	19950926	26	0
19950927	27	0	19950927	27	0
19950928	28	0	19950928	28	0
19950929	29	0	19950929	29	0
19950930	30	0	19950930	30	0
	31			31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

	October	0		October	0	
19951001	1	0	19951001	1	0	
19951002	2	0	19951002	2	0	
19951003	3	0	19951003	3	0	
19951004	4	0	19951004	4	0	
19951005	5	0	19951005	5	0	
19951006	6	0	19951006	6	0	
19951007	7	0	19951007	7	0	
19951008	8	0	19951008	8	0	
19951009	9	0	19951009	9	0	
19951010	10	0	19951010	10	0	
19951011	11	0	19951011	11	0	
19951012	12	0	19951012	12	0	
19951013	13	0	19951013	13		
19951014	14	0	19951014	14		
19951015	15	0	19951015	15		
19951016	16	0	19951016	16		
19951017	17	0	19951017	17		
19951018	18	0	19951018	18	0	
19951019	19	0	19951019	19	0	
19951020	20	0	19951020	20	0	
19951021	21	0	19951021	21	0	
19951022	22	0	19951022	22	0	
19951023	23	0	19951023	23	0	
19951024	24	0	19951024	24	0	
19951025	25	0	19951025	25	0	
19951026	26	0	19951026	26	3	
19951027	27	0	19951027	27	0	
19951028	28	24	19951028	28	0	
19951029	29	0.4	19951029	29	0	
19951030	30	0	19951030	30	0	
19951031	31	1	19951031	31	0	
	32			32		
	33			33		
	34			34		

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

November	0		November	0	
19951101	1	0	19951101	1	0
19951102	2	0.2	19951102	2	0
19951103	3	0	19951103	3	0
19951104	4	0	19951104	4	0
19951105	5	0	19951105	5	0
19951106	6	0	19951106	6	0
19951107	7	4	19951107	7	0
19951108	8	0	19951108	8	0
19951109	9	0	19951109	9	0
19951110	10	0	19951110	10	0
19951111	11	2	19951111	11	0
19951112	12	26	19951112	12	14
19951113	13	0	19951113	13	2
19951114	14	0	19951114	14	0
19951115	15	0	19951115	15	0
19951116	16	0	19951116	16	0
19951117	17	0	19951117	17	0
19951118	18	0	19951118	18	0
19951119	19	0	19951119	19	0
19951120	20	0	19951120	20	0
19951121	21	0	19951121	21	0
19951122	22	0	19951122	22	17
19951123	23	20	19951123	23	3
19951124	24	11	19951124	24	4
19951125	25	4	19951125	25	0
19951126	26	0	19951126	26	0.4
19951127	27	0	19951127	27	76
19951128	28	0	19951128	28	0
19951129	29	44	19951129	29	0
19951130	30	13	19951130	30	27
	31			31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

December	0		December	0	
19951201	1	0	19951201	1	3
19951202	2	0.2	19951202	2	0
19951203	3	0.5	19951203	3	0
19951204	4	0	19951204	4	4
19951205	5	0	19951205	5	9
19951206	6	0	19951206	6	25
19951207	7	0	19951207	7	0.3
19951208	8	0	19951208	8	13
19951209	9	0	19951209	9	0
19951210	10	0	19951210	10	0
19951211	11	0	19951211	11	
19951212	12	0	19951212	12	
19951213	13	0	19951213	13	
19951214	14	0	19951214	14	
19951215	15	0	19951215	15	
19951216	16	0	19951216	16	
19951217	17	4	19951217	17	
19951218	18	32	19951218	18	
19951219	19	0	19951219	19	
19951220	20	1	19951220	20	
19951221	21	0	19951221	21	
19951222	22	5	19951222	22	
19951223	23	0	19951223	23	
19951224	24		19951224	24	
19951225	25	31	19951225	25	
19951226	26	22	19951226	26	
19951227	27	5	19951227	27	3
19951228	28	28	19951228	28	3
19951229	29	151	19951229	29	22
19951230	30	36	19951230	30	50
19951231	31	0	19951231	31	2
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1996 Daily Precipitation (in mm)					
August	0		August	0	
19960801	1	0	19960801	1	0
19960802	2	0	19960802	2	0
19960803	3	0	19960803	3	0
19960804	4	0	19960804	4	0
19960805	5	0	19960805	5	0
19960806	6	0	19960806	6	0
19960807	7	0	19960807	7	0
19960808	8	0	19960808	8	0
19960809	9	0	19960809	9	0
19960810	10	0	19960810	10	0
19960811	11	0	19960811	11	0
19960812	12	0	19960812	12	0
19960813	13	0	19960813	13	0
19960814	14	0	19960814	14	0
19960815	15	0	19960815	15	0
19960816	16	0	19960816	16	0
19960817	17	0	19960817	17	0
19960818	18	0	19960818	18	0
19960819	19	0	19960819	19	0
19960820	20	0	19960820	20	0
19960821	21	0	19960821	21	0
19960822	22	0	19960822	22	0
19960823	23	0	19960823	23	0
19960824	24	0	19960824	24	0
19960825	25	0	19960825	25	0
19960826	26	0	19960826	26	0
19960827	27	0	19960827	27	0
19960828	28	0	19960828	28	0
19960829	29	0	19960829	29	0
19960830	30	0	19960830	30	0
19960831	31	0	19960831	31	0
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

September	0		September	0	
19960901	1	0	19960901	1	0
19960902	2	0	19960902	2	0
19960903	3	0	19960903	3	0
19960904	4		19960904	4	0
19960905	5	0	19960905	5	0
19960906	6	0	19960906	6	
19960907	7	0	19960907	7	
19960908	8	0	19960908	8	
19960909	9	0	19960909	9	0
19960910	10	0	19960910	10	0
19960911	11	0	19960911	11	0
19960912	12	0	19960912	12	0
19960913	13	0	19960913	13	0
19960914	14	0	19960914	14	0
19960915	15	0	19960915	15	0
19960916	16	0	19960916	16	0
19960917	17	0	19960917	17	0
19960918	18	0	19960918	18	0
19960919	19	0	19960919	19	0
19960920	20	0	19960920	20	0
19960921	21	0	19960921	21	0
19960922	22	0	19960922	22	0
19960923	23	0	19960923	23	0
19960924	24	0	19960924	24	0
19960925	25	0	19960925	25	0.6
19960926	26	0	19960926	26	0
19960927	27	0	19960927	27	0
19960928	28	0	19960928	28	0
19960929	29	0	19960929	29	0
19960930	30	0	19960930	30	0
	31			31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

October	0		October	0	
19961001	1	0	19961001	1	0
19961002	2	0	19961002	2	0
19961003	3	0	19961003	3	0
19961004	4	0	19961004	4	0
19961005	5		19961005	5	0
19961006	6		19961006	6	0
19961007	7	0	19961007	7	0
19961008	8	0	19961008	8	0
19961009	9	0	19961009	9	0
19961010	10	0	19961010	10	0
19961011	11	0	19961011	11	0
19961012	12	0	19961012	12	0
19961013	13	0	19961013	13	0
19961014	14	0	19961014	14	0
19961015	15	0	19961015	15	0
19961016	16	0	19961016	16	0
19961017	17	0	19961017	17	0
19961018	18	0	19961018	18	
19961019	19	0	19961019	19	
19961020	20	0	19961020	20	0
19961021	21	0	19961021	21	0
19961022	22	0	19961022	22	0
19961023	23	0	19961023	23	0
19961024	24	0	19961024	24	0
19961025	25	7	19961025	25	0
19961026	26		19961026	26	0
19961027	27		19961027	27	3
19961028	28	0	19961028	28	11
19961029	29	0	19961029	29	0
19961030	30	0	19961030	30	0
19961031	31	0	19961031	31	0
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

November	0		November	0	
19961101	1	0	19961101	1	0
19961102	2	0	19961102	2	0
19961103	3	0	19961103	3	4
19961104	4	0	19961104	4	0
19961105	5	5	19961105	5	0
19961106	6	0	19961106	6	0
19961107	7	1	19961107	7	0
19961108	8	0	19961108	8	0
19961109	9	0.6	19961109	9	0
19961110	10	0	19961110	10	0
19961111	11	0	19961111	11	0
19961112	12	0	19961112	12	0
19961113	13	0	19961113	13	0
19961114	14	0	19961114	14	0
19961115	15	0	19961115	15	0
19961116	16	0	19961116	16	0
19961117	17	0	19961117	17	0
19961118	18	0	19961118	18	0
19961119	19	0	19961119	19	0
19961120	20	0	19961120	20	0
19961121	21	0	19961121	21	
19961122	22	0	19961122	22	
19961123	23	0	19961123	23	
19961124	24	0	19961124	24	
19961125	25	0	19961125	25	0
19961126	26	0	19961126	26	0
19961127	27	6	19961127	27	0
19961128	28	0	19961128	28	0
19961129	29	0	19961129	29	0
19961130	30	0	19961130	30	0
	31			31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

December	0		December	0	
19961201	1	0	19961201	1	0
19961202	2	0	19961202	2	30
19961203	3	0	19961203	3	91
19961204	4	0	19961204	4	3
19961205	5	29	19961205	5	0
19961206	6	0	19961206	6	
19961207	7	28	19961207	7	
19961208	8	0	19961208	8	
19961209	9		19961209	9	
19961210	10		19961210	10	2
19961211	11		19961211	11	
19961212	12	0	19961212	12	
19961213	13	52	19961213	13	
19961214	14	7	19961214	14	
19961215	15	1	19961215	15	
19961216	16	12	19961216	16	0
19961217	17	26	19961217	17	11
19961218	18	6	19961218	18	13
19961219	19	0	19961219	19	16
19961220	20	0	19961220	20	10
19961221	21	1	19961221	21	15
19961222	22	0	19961222	22	5
19961223	23	0.6	19961223	23	11
19961224	24	0	19961224	24	68
19961225	25	3	19961225	25	0
19961226	26	3	19961226	26	0
19961227	27		19961227	27	
19961228	28		19961228	28	
19961229	29		19961229	29	
19961230	30	2	19961230	30	0
19961231	31	0	19961231	31	16
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

Station: 67083
(-18.80,47.48)
Vegtype: S

Station: 67017
(-19.82,47.07)
Vegtype: S

Station: 67083 (-18.80,47.48) Vegtype: S			Station: 67017 (-19.82,47.07) Vegtype: S		
Daily Precipitation (in mm)		Fire Counts	Daily Precipitation (in mm)		Fire Counts
1993 August			1993 August		
1			1		
19930803	0.4		19930801	0	
19930804	0		19930802	0	0
19930805	0	0	19930803	0.3	
			19930804	0	
			19930805	0	0
19930806	0		19930806	0	
19930807	0		19930807	0	
19930808	0		19930808	0	
19930809	0		19930809	0	
19930810	0		19930810	0	
19930811	0	107	19930811	0	160
19930812	0	398	19930812	0	74
19930813	0		19930813	0	
19930814	0		19930814	0	
19930815	15	449	19930815	15	274
19930816	0	47	19930816	0	0
19930817	0		19930817	0	
19930818	0	290	19930818	0	276
19930819	0		19930819	0	
19930820	0		19930820	0	
19930821	0		19930821	0	
19930822	0	278	19930822	0	256
19930823	0		19930823	0	
19930824	0	14	19930824	0	0
19930825	0		19930825	0	
19930826	0	0	19930826	0	0
19930827	0		19930827	0	
19930828	0	12	19930828	0	85
19930830	30	0	30		0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

September			September		
19930901	1	0	44 19930901	1	0
19930902		0	19930902		0
19930903		0	85 19930903		61
19930904		0	90 19930904		0
19930905		0.7	11 19930905		0
19930906		0	19930906		0
19930907		0	19930907		0
19930908		0	180		230
19930909		0	675		306
19930910		0	879		367
19930911		0			
19930912		0			
19930913		0			
19930914		0	1198		509
19930915	15	0	2339 19930915	15	1449
19930916		0	19930916		0
19930917		0	19930917		0
19930918		0	19930918		0
19930919		0	19930919		0
19930920		0	798 19930920		521
19930921		0	353 19930921		379
19930922		0	719 19930922		400
19930923		0	447 19930923		160
19930924		0	96 19930924		93
19930925		0	135 19930925		36
19930926		0	51 19930926		0
19930927		1	19930927		0
19930928		0	19930928		2
19930929		0	19930929		0
	30	0	0 19930930	30	0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

October			October		
19931001	1	0	1		
19931002		0.1			
19931003		0		0	0
19931004		0		394	50
19931005		0		877	584
19931006		0	19931006	8	
19931007		0	63 19931007	7	0
19931008		0	19931008	0.3	
19931009		0	1343 19931009	0	788
19931010		5	19931010	0	
19931011		0	1802 19931011	0	701
19931012		0	19931012	0	
19931013		0	1562 19931013	0	1215
19931014		0	1705 19931014	0	963
19931015	15	0	2128 19931015	0	1581
19931016		0	1353 19931016	0	720
19931017		0	1321 19931017	0	760
19931018		0	19931018	0	
19931019			862 19931019		709
19931020		0	304 19931020	0	0
19931021		0	987 19931021	0.7	120
19931022		0	121 19931022	0	104
19931023		0	19931023	0	
19931024		0.2	0 19931024	0.4	0
19931025		9	0 19931025	2	0
19931026		0	0 19931026	0	0
19931027		14	0 19931027	0	0
19931028		20	0 19931028	2	0
19931029		0.4	19931029	0	
19931030	30	0	0 19931030	0	0
19931031		0	0 19931031	0	0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1993 November			1993 November		
19931101	1	0	0 19931101	1	0 44
19931102		0	0 19931102		0 0
19931103		0.1	19931103		0
19931104		32	0 19931104		1 0
19931105		0	0 19931105		0 0
19931106		17	13 19931106		6 63
19931107		0	0 19931107		0 27
19931108		0	19931108		0
19931109		0	169 19931109		0 101
19931110		0	96 19931110		0 112
19931111		0	19931111		0.1
19931112		3	523 19931112		0 57
19931113		0	67 19931113		0 50
19931114		0	358 19931114		0 301
19931115	15	0	30 19931115	15	0 90
19931116		0	0 19931116		0 0
19931117		0	249 19931117		0 107
19931118		0	579 19931118		0 60
19931119		0	239 19931119		0 14
19931120		0	233 19931120		0 251
19931121		0	33 19931121		0 0
19931122		0	0 19931122		0 0
19931123		0	0 19931123		42 0
19931124		0	19931124		0
19931125		0	0 19931125		10 0
19931126		0.2	0 19931126		4 0
19931127		4	0 19931127		0 0
19931128		0.1	0		0
19931129		0	0 19931129		0 0
19931130	30	9	0 19931130	30	0 0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1993 December			1993 December		
19931201	1	0	0 19931201	1	0
19931202		0	0 19931202		26
19931203		0	19931203		0
19931204		0	19931204		0
19931205		0	19931205		0
19931206		0	301 19931206		0
19931207		0	425 19931207		0
19931208		0	361 19931208		0
19931209		0	169 19931209		0
19931210		0	149 19931210		0
19931211		0	19931211		33
19931212		0	150 19931212		0
19931213		0	284 19931213		9
19931214		0	357 19931214		18
19931215	15	0	261 19931215	15	0
19931216		0	410 19931216		0
19931217		0	248 19931217		0
19931218		0	0 19931218		0.1
19931219		0.6	16 19931219		0.6
19931220		0	19931220		0
19931221		0	19931221		6
19931222		0	0 19931222		0
			0		0
			0		0
			0		0
			0		0
			0		0
			0		0
19931228			0		0
19931229		47	0 19931229		18
19931230	30	24	0 19931230		40
19931231		0.3	0 19931231		4

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 August				1994 August			
		Daily Precipitation (in mm)	Fire Counts			Daily Precipitation (in mm)	Fire Counts
19940801	1	0.1	239	19940801	1	0.1	28
19940802		2	0	19940802		0.6	0
19940803		0	444	19940803		0.1	67
19940804		0	56	19940804		0	0
19940805		0	185	19940805		0.1	0
19940806		0.6		19940806		0	
19940807		0		19940807		0	
19940808		0	285	19940808		0	0
19940809		0.4	205	19940809		0	0
19940810		0	135	19940810		0	121
19940811		0	478	19940811		0	109
19940812		0		19940812		0	
19940813		0	263	19940813		0	56
19940814		0	77	19940814		0	0
19940815	15	0	186	19940815	15	0	0
19940816		0	29	19940816		0	0
19940817		0		19940817		0	
19940818		9	0	19940818		0	0
19940819		0.3	25	19940819		0	0
19940820		0	82	19940820		0	0
19940821		0	0	19940821		0	0
19940822		0	0	19940822		0	0
19940823		0.6	0	19940823		0	0
19940824		0	0	19940824		3	0
19940825		0	0	19940825		0	0
19940826		0		19940826		0	
19940827		0		19940827		0	
19940828		0	0	19940828		0	0
19940829		0	567	19940829		0	133
19940830	30	0	576	19940830	30	0	201
19940831		0	192	19940831		0	241

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 September			1994 September		
19940901	1	0	607 19940901	1	0
19940902		0	770 19940902		0
19940903		0	277 19940903		0
19940904		0	670 19940904		0.3
19940905		0	556 19940905		0
19940906		0.3	502 19940906		0
19940907		0	360 19940907		0
19940908		0	285 19940908		0
19940909		0	421 19940909		0
19940910		0	19940910		0
19940911		0	582 19940911		0
19940912		0	0 19940912		0
19940913		0	177 19940913		0
19940914		0	0 19940914		0
19940915	15	44	0	15	0
19940916		0	0		0
19940917		0	59		0
19940918		0	117		26
19940919		0	83		0
19940920		0	293		14
19940921		0	203		0
19940922		0	43		0
19940923		0			
19940924		0	566		121
19940925		0			
19940926		0	695 19940926		0
19940927		0	973 19940927		0
19940928		0	1130 19940928		0
19940929		0	1366 19940929		0
19940930	30	0	1039 19940930	30	0

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 October			1994 October		
19941001	1	0	1716 19941001	1	0 326
19941002		0	1059 19941002		0 71
19941003		0	0 19941003		0 0
19941004		85	19941004		37
19941005		0	19941005		3
19941006		0.4	19941006		14
19941007		0.3	36 19941007		17 44
19941008		3	244 19941008		15 345
19941009		0	227 19941009		0 37
19941010		2	42 19941010		0 0
19941011		23	42 19941011		0 0
19941012		7	0 19941012		0 0
19941013		0	0 19941013		0 0
19941014		0	19941014		0
19941015	15	0.1	210 19941015	15	6 0
19941016		0	26 19941016		1 0
19941017		0	0 19941017		0.4 0
19941018		0	0 19941018		4 0
19941019		0	19941019		4
19941020		0	42 19941020		0.4 0
19941021		0	167 19941021		0 75
19941022		0	0 19941022		0 40
19941023		0.5	45 19941023		0 68
19941024		0	19941024		0
19941025		6	0 19941025		0 0
19941026		0	128 19941026		0 0
19941027		0.6	385 19941027		16 390
19941028		0	386 19941028		0 299
19941029		0	1055 19941029		0 263
19941030	30	0	1000 19941030	30	0 347
19941031		0	212 19941031		0 286

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 November			1994 November		
19941101	1	0	648 19941101	1	0
19941102		0	53 19941102		4
19941103		0	19941103		0
19941104		0	19941104		0
19941105		0	19941105		0
19941106		0	1294 19941106		0
19941107		0	19941107		0
19941108		0	19941108		0
19941109		0	879 19941109		0
19941110		0	0 19941110		0
19941111		0	372 19941111		9
19941112		0	179 19941112		0
19941113		0	150 19941113		0
19941114		0	0 19941114		0
19941115	15	0	13 19941115	15	0
19941116		0	407 19941116		0
19941117		0	384 19941117		0
19941118		0	277 19941118		0
19941119		0	543 19941119		0
			98		10
			62		0
			375		16
			278		15
			0		0
19941124		8	0 19941125		13
19941125		8	25 19941126		0
19941126		0	37 19941127		0
19941127		0	303 19941128		0
19941128		0	0		0
19941129		0			
19941130	30	0		30	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1994 December			1994 December		
19941201	1	0	19941201	1	0
19941202		0	19941202		0
19941203		0	19941203		0
19941204		5	19941204		5
19941205		17	19941205		17
19941206		0.2	19941206		0.2
19941207		0	19941207		0
19941208		0	19941208		0
19941209		0	19941209		0
19941210		0	19941210		0
19941211		0	19941211		0
19941212		0	19941212		0
19941213		0	19941213		0
19941214		9	19941214		9
19941215	15	12	19941215	15	12
19941216		10	19941216		10
19941217		6	19941217		6
19941218		19	19941218		19
19941219		97	19941219		97
19941220		0	19941220		0
19941221		0	19941221		0
19941222		0	19941222		0
19941223		0	19941223		0
19941224		0	19941224		0
19941225		0	19941225		0
19941226		2	19941226		2
19941227		0	19941227		0
19941228		0	19941228		0
19941229		0	19941229		0
19941230	30	0	19941230	30	0
19941231		14	19941231		14

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1995 Daily Precipitation (in mm)			1995 Daily Precipitation (in mm)		
August	0		August	0	
19950801	1	0	19950801	1	0
19950802	2	0	19950802	2	0
19950803	3	0	19950803	3	0
19950804	4	0.2	19950804	4	0
19950805	5	0	19950805	5	0
19950806	6	0	19950806	6	0
19950807	7	0.5	19950807	7	0
19950808	8	0	19950808	8	0
19950809	9	0	19950809	9	0
19950810	10	0.6	19950810	10	0
19950811	11	0	19950811	11	0
19950812	12	0	19950812	12	0
19950813	13	0	19950813	13	0
19950814	14	0	19950814	14	-99.9
19950815	15	-99.9	19950815	15	
19950816	16	0	19950816	16	
19950817	17	0	19950817	17	
19950818	18	0	19950818	18	
19950819	19	0.2	19950819	19	
19950820	20	0	19950820	20	
19950821	21	0	19950821	21	
19950822	22	0	19950822	22	
19950823	23	0	19950823	23	
19950824	24	0	19950824	24	
19950825	25	0	19950825	25	
19950826	26	0	19950826	26	
19950827	27	0	19950827	27	
19950828	28	0	19950828	28	
19950829	29	0	19950829	29	
19950830	30	0	19950830	30	
19950831	31	0	19950831	31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

September	0		September	0	
19950901	1	0	19950904	4	0
19950902	2	0	19950905	5	0
19950903	3	0	19950906	6	0
19950904	4	0	19950907	7	0
19950905	5	0	19950908	8	0
19950906	6	0	19950909	9	0
19950907	7	0	19950910	10	0
19950908	8	0	19950911	11	0
19950909	9	0	19950912	12	0
19950910	10	0	19950913	13	0
19950911	11	0	19950914	14	0
19950912	12	0	19950915	15	0
19950913	13	0	19950916	16	0
19950914	14	0	19950917	17	0
19950915	15	0	19950918	18	0
19950916	16	0	19950919	19	0
19950917	17	0	19950920	20	6
19950918	18	0	19950921	21	0
19950919	19	0	19950922	22	0
19950920	20	0	19950923	23	0.1
19950921	21	0	19950924	24	0
19950922	22	0	19950925	25	0
19950923	23	0	19950926	26	0
19950924	24	0	19950927	27	0
19950925	25	0	19950928	28	0
19950926	26	0	19950929	29	0
19950927	27	0	19950930	30	0
19950928	28	0		31	
19950929	29	0		32	
19950930	30	0		33	
	31			34	
	32				
	33				
	34				

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

October	0		October	0	
19951001	1	0	19951001	1	0
19951002	2	0	19951002	2	0
19951003	3	0	19951003	3	0
19951004	4	0	19951004	4	0
19951005	5	0	19951005	5	0
19951006	6	0	19951006	6	0
19951007	7	0	19951007	7	0
19951008	8	0	19951008	8	0
19951009	9	0	19951009	9	0
19951010	10	0	19951010	10	0
19951011	11	0	19951011	11	0
19951012	12	0	19951012	12	0
19951013	13	0	19951013	13	0
19951014	14	0		14	
19951015	15	0		15	
19951016	16	0	19951016	16	0
19951017	17	0	19951017	17	0
19951018	18	0	19951018	18	0
19951019	19	0	19951019	19	0
19951020	20	0	19951020	20	0
19951021	21	0	19951021	21	-99.9
19951022	22	0	19951022	22	0
19951023	23	0	19951023	23	0
19951024	24	0	19951024	24	0
19951025	25	0	19951025	25	0
19951026	26	0	19951026	26	0
19951027	27	0	19951027	27	0
19951028	28	0	19951028	28	0
19951029	29	0	19951029	29	0
19951030	30	0.5	19951030	30	1
19951031	31	0	19951031	31	0
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

November	0		November	0	
19951101	1	0	19951101	1	0
19951102	2	0	19951102	2	0
19951103	3	0		3	
19951104	4	0		4	
19951105	5	0		5	
19951106	6	0		6	
19951107	7	0		7	
19951108	8	0	19951108	8	0
19951109	9	0	19951109	9	0
19951110	10	0	19951110	10	7
19951111	11	0	19951111	11	9
19951112	12	0	19951112	12	0.5
19951113	13	0	19951113	13	5
19951114	14	6	19951114	14	9
19951115	15	0	19951115	15	3
19951116	16	0	19951116	16	0.1
19951117	17	0	19951117	17	0
19951118	18	0	19951118	18	0
19951119	19	0	19951119	19	0
19951120	20	0	19951120	20	0
19951121	21	0	19951121	21	3
19951122	22	3	19951122	22	0
19951123	23	0	19951123	23	4
19951124	24	0	19951124	24	10
19951125	25	2	19951125	25	3
19951126	26	24	19951126	26	0.3
19951127	27	1	19951127	27	2
19951128	28	17	19951128	28	7
19951129	29	0	19951129	29	0
19951130	30	0	19951130	30	0
	31			31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

December	0		December	0	
19951201	1	0	19951201	1	2
19951202	2	0	19951202	2	11
19951203	3	18	19951203	3	21
19951204	4	10	19951204	4	16
19951205	5	0.3	19951205	5	7
19951206	6	3	19951206	6	16
19951207	7	0.3	19951207	7	0.6
19951208	8	0	19951208	8	0
19951209	9	0	19951209	9	0
19951210	10	0	19951210	10	0
19951211	11	21	19951211	11	2
19951212	12	24	19951212	12	2
19951213	13	23	19951213	13	0
19951214	14	35	19951214	14	16
19951215	15	1	19951215	15	4
19951216	16	11	19951216	16	1
19951217	17	15	19951217	17	5
19951218	18	0	19951218	18	0.2
19951219	19	0	19951219	19	5
19951220	20	0	19951220	20	0
19951221	21	6	19951221	21	0
19951222	22	0	19951222	22	3
19951223	23	37		23	
19951224	24	0.2		24	
19951225	25	2		25	
19951226	26	78	19951226	26	52
19951227	27	48	19951227	27	33
19951228	28	43	19951228	28	29
19951229	29	10		29	
19951230	30	12		30	
19951231	31	5		31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

1996 Daily Precipitation (in mm)			1996 Daily Precipitation (in mm)		
August	0		August	0	
19960801	1	0	19960801	1	0
19960802	2	0	19960802	2	0
19960803	3	0	19960803	3	0
19960804	4	0	19960804	4	0
19960805	5	0	19960805	5	0
19960806	6	0	19960806	6	0
19960807	7	0	19960807	7	0
19960808	8	0	19960808	8	0
19960809	9	0	19960809	9	0
19960810	10	0	19960810	10	0
19960811	11	0	19960811	11	0
19960812	12	0	19960812	12	0
19960813	13	0	19960813	13	0
19960814	14	0	19960814	14	0
19960815	15	0		15	
19960816	16	0.2	19960816	16	0
19960817	17	0	19960817	17	0
19960818	18	0	19960818	18	0
19960819	19	0	19960819	19	0
19960820	20	0	19960820	20	0
19960821	21	0	19960821	21	0
19960822	22	0	19960822	22	0
19960823	23	6		23	
19960824	24	0		24	
19960825	25	0		25	
19960826	26	0	19960826	26	0
19960827	27	0	19960827	27	0
19960828	28	0	19960828	28	0
19960829	29	0	19960829	29	0
19960830	30	0	19960830	30	0
19960831	31	0	19960831	31	0
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

September	0		September	0	
19960901	1	0	19960901	1	0
19960902	2	0	19960902	2	0
19960903	3	0	19960903	3	0
19960904	4	0	19960904	4	0
19960905	5	8	19960905	5	0
19960906	6	0	19960906	6	0
19960907	7	0	19960907	7	0
19960908	8	0	19960908	8	0
19960909	9	0	19960909	9	0
19960910	10	0	19960910	10	0
19960911	11	0	19960911	11	0
19960912	12	0	19960912	12	0
19960913	13	0	19960913	13	0
19960914	14	0	19960914	14	0
19960915	15	0	19960915	15	0
19960916	16	0	19960916	16	0
19960917	17	0	19960917	17	0
19960918	18	0	19960918	18	0
19960919	19	0	19960919	19	0
19960920	20	0	19960920	20	0
19960921	21	0	19960921	21	0
19960922	22	0	19960922	22	0
19960923	23	0	19960923	23	0
19960924	24	0	19960924	24	0
19960925	25	0	19960925	25	0
19960926	26	0	19960926	26	0
19960927	27	0	19960927	27	0
19960928	28	0	19960928	28	0
19960929	29	0	19960929	29	0
19960930	30	0	19960930	30	0
	31			31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

October	0		October	0	
19961001	1	0	19961001	1	0
19961002	2	0	19961002	2	0
19961003	3	0	19961003	3	0
19961004	4	0	19961004	4	0
19961005	5	-99.9		5	
19961006	6	0		6	
19961007	7	0	19961007	7	0
19961008	8	0	19961008	8	0
19961009	9	0	19961009	9	0
19961010	10	0	19961010	10	0
19961011	11	0	19961011	11	0
19961012	12	0	19961012	12	0
19961013	13	0	19961013	13	0
19961014	14	0	19961014	14	0
19961015	15	0	19961015	15	0
19961016	16	0	19961016	16	0
19961017	17	0	19961017	17	0.3
19961018	18	0		18	
19961019	19	0		19	
19961020	20	0		20	
19961021	21	4	19961021	21	0
19961022	22	0	19961022	22	0
19961023	23	0	19961023	23	0
19961024	24	0	19961024	24	0
19961025	25	0	19961025	25	0
19961026	26	0		26	
19961027	27	0		27	
19961028	28	0	19961028	28	0
19961029	29	0	19961029	29	0
19961030	30	0	19961030	30	0
19961031	31	0	19961031	31	5
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

November	0		November	0	
19961101	1	0	19961101	1	0.2
19961102	2	7	19961102	2	6
19961103	3	0	19961103	3	0
19961104	4	0	19961104	4	0
19961105	5	0	19961105	5	0
19961106	6	0	19961106	6	0
19961107	7	0	19961107	7	0
19961108	8	0	19961108	8	0
19961109	9	0	19961109	9	0
19961110	10	0	19961110	10	0
19961111	11	0	19961111	11	0
19961112	12	0	19961112	12	0
19961113	13	0	19961113	13	0
19961114	14	0	19961114	14	0
19961115	15	0	19961115	15	46
19961116	16	6	19961116	16	2
19961117	17	0	19961117	17	0.2
19961118	18	0	19961118	18	34
19961119	19	0	19961119	19	0
19961120	20	0	19961120	20	0
19961121	21	0	19961121	21	0
19961122	22	0	19961122	22	0
19961123	23	0	19961123	23	0
19961124	24	0	19961124	24	0
19961125	25	0	19961125	25	0
19961126	26	0	19961126	26	0
19961127	27	0	19961127	27	0
19961128	28	0	19961128	28	0.5
19961129	29	2	19961129	29	3
19961130	30	0	19961130	30	0
	31			31	
	32			32	
	33			33	
	34			34	

Appendix C. Daily Precipitation and fire Counts for Six Selected 1° X 1° Grid Cells Where Six Weather Stations Located

December	0		December	0	
19961201	1	0	19961201	1	0
19961202	2	5	19961202	2	0.1
19961203	3	31	19961203	3	26
19961204	4	0.7		4	
19961205	5	0		5	
19961206	6	0		6	
19961207	7	0		7	
19961208	8	0.2		8	
19961209	9	23		9	
19961210	10	1		10	
19961211	11	11		11	
19961212	12	27		12	
19961213	13	0		13	
19961214	14	14		14	
19961215	15	12	19961215	15	10
19961216	16	2	19961216	16	0
19961217	17	5	19961217	17	6
19961218	18	15	19961218	18	3.2
19961219	19	3	19961219	19	0
19961220	20	17	19961220	20	2
19961221	21	89	19961221	21	0
19961222	22	4	19961222	22	39
19961223	23	24	19961223	23	34
19961224	24	21	19961224	24	4
19961225	25	49	19961225	25	2
19961226	26	22	19961226	26	0
	27			27	
	28			28	
19961229	29	-99.9		29	
19961230	30	3	19961230	30	50
19961231	31	0	19961231	31	4
	32			32	
	33			33	
	34			34	

Appendix D. Madagascar Vegetation Map and Weather Stations

